JUL 28 1924

PUBLIC WORKS

CITY COUNTY STATE

Executive Avenue, Washington, D. C., at State, War and Navy Building. Tarvia-built in 1911, this street is still in excellent condition after 13 years of traffic.

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This oldtime car is rust

—but the street is still good

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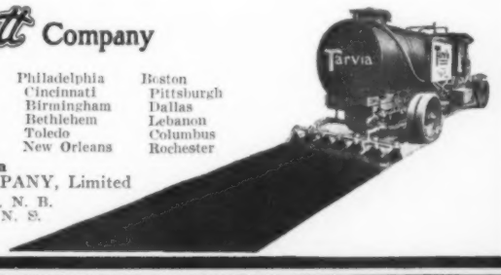
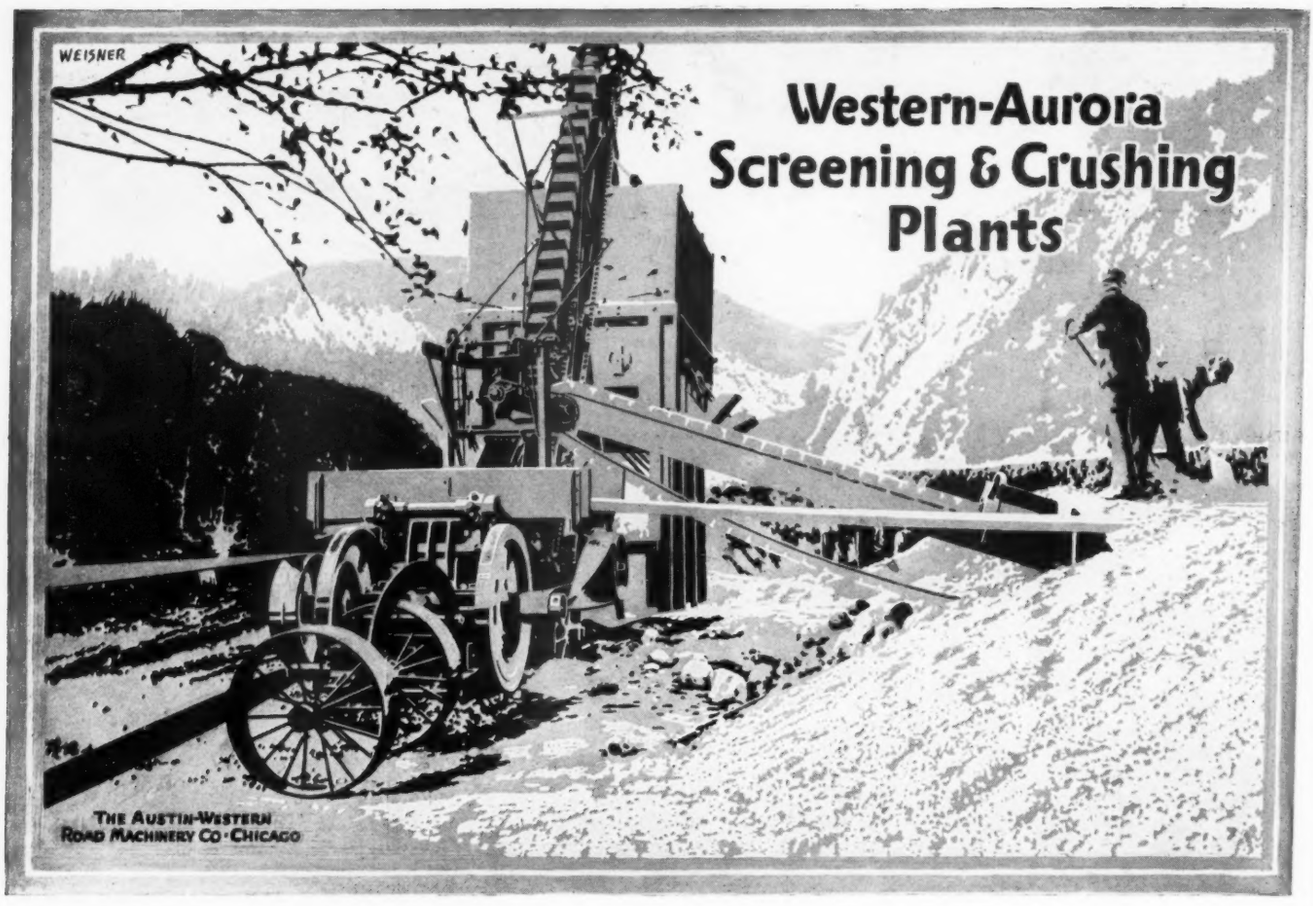


JULY, 1924



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Vol. 55 July, 1924 No. 7

Nine Years' Operation of the Baltimore Sewage Pumping Station

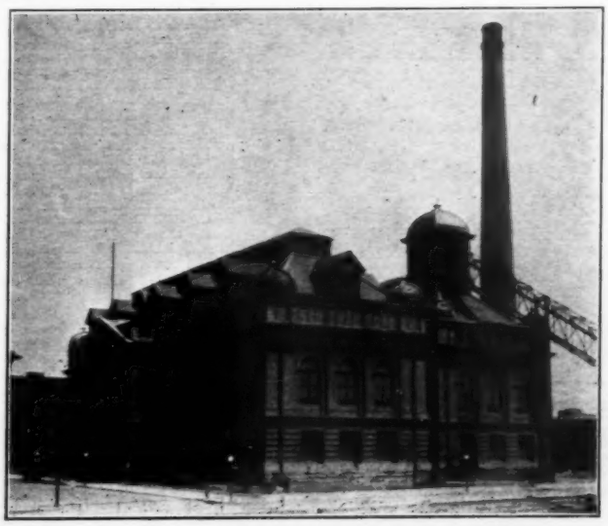
Description of plant and details of operation, including amount of screenings, slip and duty of pumps, and cost of operation for each year from 1915 to 1923, inclusive

By C. E. Keefer*

At the present time there are only a few sewage pumping stations in this country equipped with vertical triple-expansion pumping engines. One of these is the Eastern Avenue Pumping Station in Baltimore. The design of this station was started in 1906; construction work was begun in 1907, and it was put in operation on January 31, 1912. Since then the station has operated continuously and has given excellent service.

DESCRIPTION OF THE STATION

The pumping station is situated in the central section of the city, at Eastern avenue and Jones Falls, with adequate rail and water facilities. The sewage from a large portion of the city flows through two interceptors to the station. One of these, the west low-level interceptor, which is 84 in. in diameter, serves the southern and southwestern part of the city, and the other interceptor, which is 60 in. in diameter, serves the southeastern section of the city. Both interceptors are near the harbor, and at their deepest points, adjacent to the pumping station, are 13 ft. below mean low tide.



EXTERIOR VIEW OF SEWAGE PUMPING STATION.

GRIT CHAMBER

Before entering the station the sewage flows through a small underground grit chamber below the surface of the street. This chamber is 46 ft. 6 in. long and 15 ft. 9 in. wide. It contains two channels, each 4.0 ft. wide. No means are provided for mechanically cleansing it. As the separate system of sewers is used in Baltimore, there is no street-wash, sand or grit of any appreciable amount to reach the pumps and give trouble. This grit chamber is too small to remove much of the grit, and so it is rarely if ever cleaned.

SEWAGE SCREENS

After flowing through the grit chamber the sewage enters two adjacent channels, in each of which there are two electrically-operated bar cages in series. Each cage is 8 ft. 1 in. high, 7 ft. 6 in. wide and 3 ft. 3 in. deep. The three sides of the cages consist of ¾ in. circular bars, staggered so that the clear openings are 1 in. From the cages the sewage passes through bar gratings to the suction wells of the pumps. These gratings are set parallel to the general flow of the sewage in the screen room; they make an angle of 74 degrees with the horizontal and have ¾-in. clear openings. Only a small amount of material is collected on these screens, as most of it is caught in the cage screens. The gratings were installed to give double insurance against material reaching the pumps and interfering with the operation of the pump valves. The screen room is provided with a steam-operated screen-press, which holds 6.28 cu. ft. of screenings. All of the screenings are pressed before they are incinerated.

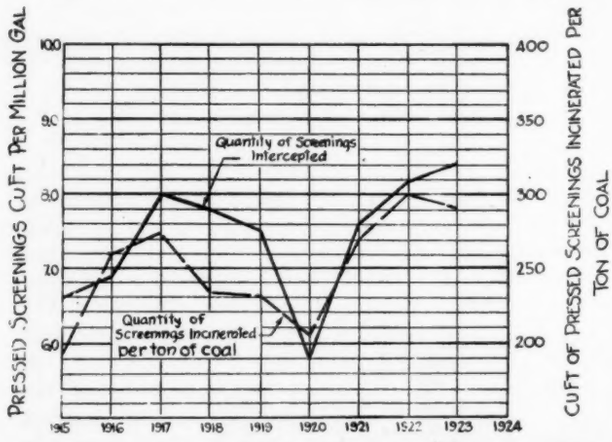
Adjacent to the screen room is a small incinerating room with two incinerators for burning the screenings. The screenings are hauled by hand in half-yard industrial cars from the press to the incinerators. The piping for the boiler-feed water passes through one of the incinerators for pre-

*Engineer of Sewage Disposal, Dept. of Public Improvements, Baltimore, Md.

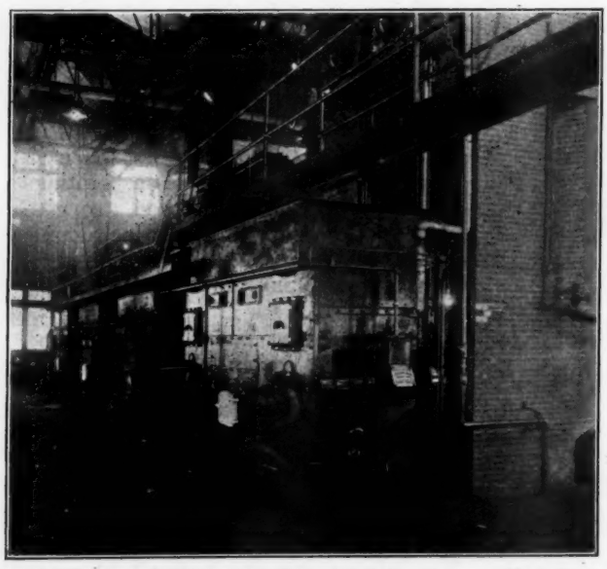
heating this water. This incinerator is used continually unless it is necessary to repair it, at which times the other incinerator is operated.

There are no direct means of communication from the screen room and the incinerating room to the other parts of the station. Although this layout has some small disadvantages, it has been a good arrangement, as odors are not carried from the sewage or screenings to the other parts of the building.

Six laborers are employed in the screen room and the incinerating room. These men are on duty 7 days a week with two men on each eight-hour shift. Each bar cage is cleaned every 30 minutes unless unusual quantities of screenings are being caught. The quantity of pressed screenings for the years 1914-23 inclusive has averaged 7.43 cu. ft. per million gallons with a minimum of 5.83 cu. ft. in 1920, and a maximum of 8.40 cu. ft. in 1923, as indicated in Table I. As the ratio of unpressed to pressed screenings is about two to one, the quantity of screenings intercepted is very great. The most apparent explanation for this condition is that the sewage is



QUANTITY OF SCREENINGS INTERCEPTED PER MILLION GALLONS AND AMOUNT INCINERATED PER TON OF COAL.



BOILER ROOM OF SEWAGE PUMPING PLANT.

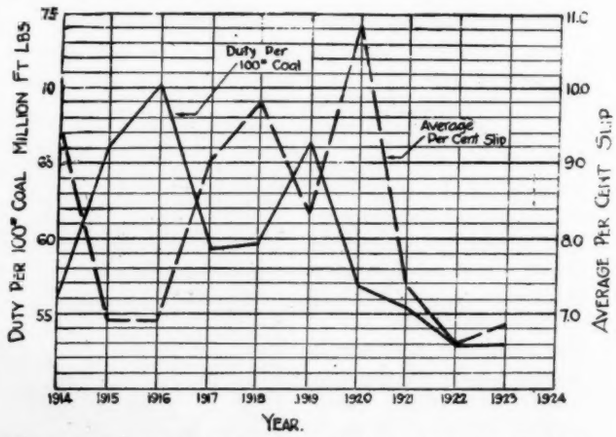
Table I. Screenings Intercepted and Incinerated at the Eastern Ave. Sewage Pumping Station

Year	Pressed Screenings: Total Quantity, Cu. Ft. (1)	Pressed Screenings: Cu. Ft. per Million Gallons (2)	Cu. Ft. of Coal Used to Incinerate Screenings Tons (3)	Cu. Ft. of Screenings Incinerated per Ton of Coal (4)
1915	43,014	6.59	221.86	193.88
1916	52,519	6.93	203.07	258.63
1917	65,053	8.03	237.68	273.70
1918	74,993	7.80	321.17	233.50
1919	70,848	7.53	306.41	231.22
1920	55,846	5.83	269.73	207.04
1921	63,561	7.58	233.83	271.82
1922	69,943	8.16	232.89	300.33
1923	68,602	8.40	234.28	292.82

Table II. Per Cent. Slip and Duty Per 100 Lbs. of Coal At the Eastern Ave. Sewage Pumping Station

Year	Sewage Pumped Million Gallons (1)	Total Displacement Million Gallons (2)	Per Cent. Slip (3)	Work Done Million Ft.-Lbs. (4)	Duty per 100 lbs. of Coal.** Million Ft.-Lbs. (5)
1914*	3,818.98	4,217.31	9.45	2,191,594.9	55.92
1915	6,525.13	7,006.45	6.87	3,839,387.3	66.11
1916	7,573.99	8,135.21	6.90	4,519,844.1	70.25
1917	8,100.77	8,960.98	9.00	4,847,570.8	59.32
1918	9,613.22	10,655.95	9.79	5,770,240.1	59.80
1919	9,405.74	10,256.19	8.29	5,482,474.7	66.20
1920	9,580.19	10,742.15	10.82	5,690,555.6	56.83
1921	8,381.68	9,046.90	7.35	5,048,082.4	55.42
1922	8,443.74	9,038.05	6.58	5,097,970.5	52.76
1923	8,165.24	8,767.88	6.87	4,937,840.1	52.94

*Quantities for January to March, inclusive, not included.
**Duty includes heating the station, and operating electric generators and auxiliary pumps.



DUTY PER 100 POUNDS OF COAL AND AVERAGE PER CENT SLIP.

chiefly from the business and industrial sections of the city.

PUMP AND ENGINE ROOM

The pump and engine room is 182 ft. long, 56 ft. wide and 102 ft. high. It is equipped with three vertical triple-expansion pumping engines. Each engine has a rated capacity for pumping 27.5 M. G. D. of sewage against a total head of 72 ft. when operating at 20 revolutions a minute. Space has been provided so that two additional pumps of a similar size can be installed. When preliminary designs were made of the station in 1906 centrifugal pumps had not reached their present stage of perfection, and for that reason they were not used even though the first cost would have been considerably

Table IV. Cost of Operating the Eastern Ave. Sewage Pumping Station for the Years 1915-1923

Year	Boiler Room Coal Amount Used Tons	Boiler Room Coal Cost	Cost of Coal for Incinerating Screenings	Oil	Packing	Waste	Supervision and Labor	Material	Total Cost, Material and Labor
1915	2,598.91	$ 7,276.94	$ 621.19	$260.35	$220.09	$ 91.63	$23,808.71	$ 1,034.33	$33,313.24
1916	2,878.18	8,599.09	612.08	217.70	170.64	134.06	25,378.38	3,791.23	38,903.18
1917	3,672.44	16,562.56	1,449.26	277.44	287.50	248.44	26,704.97	5,361.58	50,891.75
1918	4,318.01	21,012.31	1,648.45	475.40	320.83	329.35	32,519.33	9,391.29	65,696.96
1919	4,070.58	21,052.79	1,573.20	683.93	142.57	269.99	39,932.96	11,413.28	75,068.72
1920	4,486.52	41,021.72	2,390.87	936.03	290.43	253.69	47,671.53	6,607.39	99,171.66
1921	4,070.09	25,597.80	1,416.59	812.50	321.34	193.18	49,688.29	12,746.53	90,776.23
1922	4,318.54	28,811.06	1,541.64	548.22	303.83	188.08	48,460.78	7,399.63	87,253.04
1923	4,191.53	24,876.13	1,381.34	392.91	402.15	185.25	47,573.90	8,201.90	83,013.58

Table III. Cost of Operating Eastern Ave. Sewage Pumping Station

Year	Total Cost of Operation (1)	Pumpage M.G.D. (2)	Average Total Head Feet (3)	Total Pumpage Million Ft.-Gal. (4)	Cost per Million Ft.-Gal. (5)
1915	$33,313.24	17.88	70.50	460,021.67	$.0724
1916	38,903.18	20.69	71.49	541,464.55	.0718
1917	50,891.75	22.19	71.72	580,987.22	.0876
1918	65,696.96	26.34	71.98	691,959.58	.0949
1919	75,068.72	28.16	69.91	657,555.28	.1142
1920	99,171.66	26.18	71.25	682,588.54	.1453
1921	90,776.23	22.96	72.21	605,241.11	.1500
1922	87,253.04	23.13	72.37	611,073.46	.1428
1923	83,013.58	22.37	72.52	592,143.20	.1402

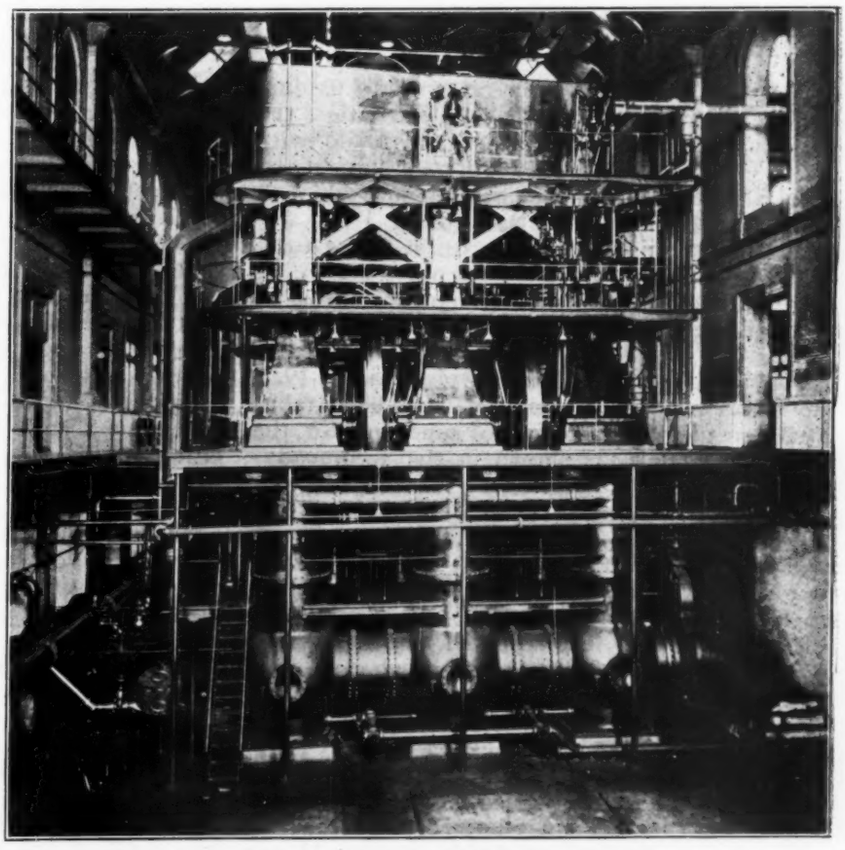
less. It is very likely, however, that the pumps which will be installed in the future will be centrifugals. During a large portion of the day only one pump is operated. The second pump is put in service during periods of peak load. No definite schedule is maintained in operating these pumps except that the total length of time that each has been in service is about the same. Table II shows the duty of the pumps and the boilers per 100 lb. of coal and the per cent. of slip, together with the total work done in million foot-pounds for the years 1914 to 1923 inclusive. As is to be expected, the duty usually varied inversely as the per cent. slip. The duty given in Table II is not strictly the duty of the pumps, as steam is also used to operate a 35 K. W. turbo-generator, a 12-in. steam-driven centrifugal pump, and to heat the station.

The above-mentioned turbo-generator furnishes all of the electric power used at the station, and supplies current for operating all of the gate valves, for lighting purposes, for lifting the cages used in screening, and for other miscellaneous purposes. There are two steam-driven centrifugal pumps, which have a capacity of 3,000 gallons per minute. They pump water to the condensers of the main pumping engines.

The three triple-expansion pumps connect direct to the two 42-in. cast iron force mains, which are about 5,300 ft. long. Each main contains a 42-in. x 21-in. Venturi meter. There are no by-passes from the station to the harbor. As there is always some danger that both force mains might break at the same time, plans are being prepared for a by-pass.

BOILER ROOM

The boiler room is 94 ft. long, 50 ft. wide, and contains three 266-h.p. water-tube boilers and one 400-h.p. water-tube boiler. Each boiler is equipped with stokers and economizers. The boilers are usually operated in rotation. If the large boiler is running, one of the small boilers is kept ready with banked fires to be put in service at any time. If the large boiler is not being used, two of the small boilers take the load. A boiler is kept in service from two weeks to three months or longer, until it is necessary to shut it down for repairs. There are



INTERIOR OF PUMP AND ENGINE ROOM.

bunkers above the boilers where 1,200 tons of coal can be stored. All of the coal used is brought to the station in scows, and hoisted in buckets to the bunkers.

MACHINE SHOP

The station is also provided with a machine shop and tool room where a large portion of the repair work is done. There are also several offices for the superintendent and for other miscellaneous purposes.

COST OF OPERATION

Table III gives the total cost of operating the station from 1915 to 1923, together with the sewage pumped, the average total head, and the cost of pumping per million foot-gallons. From 1915 to 1918 the operating costs were comparatively low, as the cost of labor and coal was small as compared with later years. The quantity of sewage pumped reached a maximum in 1919, and since then it has been dropping off. The reason for this is that the water consumption of the city has been decreasing, brought about by a campaign conducted to conserve water. A reduction in the water consumption has saved the city a considerable sum of money by keeping down the cost of operating the sewage pumping station. Column 5 of the table shows the cost of pumping per million foot-gallons. The maximum cost was $.15 in 1921, and the minimum was $.072 in 1915. Table IV gives the itemized cost of operating the station, and contains the cost of coal, labor, materials, etc.

At the present time there are 32 men employed at the station. There are 1 superintendent, 7 engineers, 4 oilers, 3 machinists, 4 firemen, 6 screen men, 6 laborers, and 1 janitor.

The station is under the supervision of B. L. Crozier, highways engineer, with M. J. Ruark, division engineer of sewers. The writer has general direction over the station, and Geo. Frick is the superintendent.

Sewer Construction in the United States

Relative amounts of vitrified, cement and cast iron pipe, and of concrete, brick and segment block sewers laid in 1923, and distribution by sizes. Amounts that city engineers anticipate will be laid this year.

Questionnaires have been returned to us during the past month from about 500 cities, the principal information on which had to do with the amount of sewers of different kinds and sizes laid during 1923 and the amount which it was expected would be laid during 1924. Instead of publishing this information in the form of tables, as heretofore has been our practice, we have summarized the more important information and present it in this form in the following paragraphs.

Taking, first, the amount of pipe laid in 1923, the totals of this information have been tabulated for the various sizes of pipe and for the various materials, as shown in the accompanying table.

From this table it is seen that vitrified clay pipe is used by 369 of the cities reporting; cement pipe by 94 of them; monolithic concrete sewers by 51; brick sewers by 21; segment block sewers by 43, and cast-iron pipe by 16.

The total lineal feet reported as having been laid in 1923 is as follows: Vitrified clay pipe, 5,319,219; cement pipe, 904,570; concrete sewer, 162,558; brick sewer, 131,425; segment block sewer, 129,718; cast-iron pipe, 13,742.

Reducing these to percentages, we find that 92 per cent. of the cities use vitrified clay pipe; 23 per cent. use cement pipe; 13 per cent. concrete sewers; 5 per cent. brick sewers; 11 per cent. segment block sewers, and 4 per cent. cast-iron sewers. The percentage which each kind of sewer constitutes of the total sewers laid were as follows: Vitrified pipe, 79.9 per cent.; cement pipe, 13.6 per cent.; concrete sewer, 2.4 per cent.; brick sewers, 2.0 per cent.; segment block sewers, 1.9 per cent.; cast-iron, 0.2 per cent.

The figures as to quantities laid are so large that the lengths may be more readily comprehended if reduced to miles. Doing this, we find that the amount of vitrified clay pipe reported by these 369 cities was 1,007 miles; that 94 cities laid 171 miles of cement pipe, that 51 cities laid 31 miles of monolithic concrete sewers, that 25 cities laid 25 miles of brick sewers, and that 43 cities laid 25 miles of segment block sewer. This gives a total of 1,262 miles of sewer laid by the 438 cities reporting.

Several points of interest are developed by an examination of the sizes of sewers laid. The figures given under each class and opposite each size are the percentages which that size is of all the sewers of its class. For instance, we find that of the vitrified pipe sewers, 45.4 per cent. of the amount laid was 8-inch. No vitrified sewers larger than 36-inch were reported and half of the total length was 8-inch and smaller.

Cement pipe was used of sizes from 6 inches up to 72 inches, although the amount larger than 36-inch was only 6½ per cent. of the whole. Of the total of this class of pipe, 50 per cent. was 15-inch and smaller.

SEWERS LAID IN 1923

Summary of information furnished by four hundred and thirty-eight cities

	Vitrified Clay Pipe	Cement Pipe	Concrete Sewers	Brick Sewers	Segment Block	Cast Iron
Number of cities reporting	369	94	51	21	43	16
Total amount reported (ft.)	5,319,219	904,570	162,558	131,425	129,718	13,742
Per Cent. of cities	92	23	13	5	11	4
Per Cent. of total length	79.9	13.6	2.4	2.0	1.9	0.2
Size of Sewer (inches)	**Percentage of Each Size Laid**					
4	0.5	..	..	..	..	7.3
6	11.2	9.2	..	..	..	10.2
8	45.4	25.0	..	..	..	13.2
10	8.4	7.0	..	..	..	45.3
12	13.8	7.8	..	..	..	9.8
15	9.5	4.0	..	..	..	..
18	4.0	5.4	..	..	..	1.0
20 and 21	2.2	1.2	..	..	..	4.1
22	0.4	2.7	..	..	..	..
24	3.7	7.1	0.3	..	..	3.5
27	0.3	5.6	1.4	2.8	1.1	..
30	0.5	14.4	9.3	15.1	7.3	2.6
33	0.05	0.9	0.6	3.4	6.1	..
36	0.05	3.1	5.3	15.5	20.1	3.0
39 and 40	..	0.3	2.9	5.9	4.1	..
42	..	1.8	4.0	13.3	15.5	..
45	..	0.4	1.0	1.1	2.6	..
48	..	1.6	10.9	5.1	12.2	..
51	..	0.4	0.9	10.4	1.4	..
54	..	1.1	3.4	1.7	6.8	..
57	..	0.6	1.2	1.1	1.2	..
60	..	..	3.1	4.6	4.8	..
66	..	..	0.6	5.4	5.0	..
69	..	..	..	..	0.2	..
72	..	0.4	4.0	6.3	7.2	..
75	..	..	..	..	0.2	..
78	..	..	0.4	..	4.2	..
84	..	..	2.1	1.3	..	..
90	..	..	1.3	..	..	..
96	..	..	4.6	1.0	..	..
102 and 108	..	..	1.5	..	..	..
110 to 144	..	..	1.7	5.8	..	..
30 to 120	..	..	20.2	..	..	..
Box, horseshoe, etc.						
2x2 to 5x 9	..	..	10.6	0.2	..	..
6x8 to 7x11	..	..	8.7	..	..	..
Not given (feet)	229,536	50,166	..	..	..	4,000

Concrete sewers were made as small as 24-inch and as large as 144-inch. Over 80 per cent. were made of circular section, 19.3 per cent. being box sewers, horseshoe shape and other forms. Of the concrete sewers, 50 per cent. were between 24 inches and 57 inches in diameter.

The range of brick sewers was practically the same as that of concrete, but a greater percentage were in the smaller sizes, 50 per cent. of the length being between 27 and 42 inches in diameter. However, 6 per cent. were 110 inches or more in diameter. Only 0.2 per cent. of the total of the brick sewers were other than circular in section.

Segment block sewers varied in size from 27 to 78 inches, 50 per cent. being from 27 to 42 inches in diameter, or the same as the brick sewer.

Cast-iron pipe varied from 4 inches to 36 inches in diameter, 75 per cent. of it being 10 inches and smaller. This was probably used for stream crossings, outlets, pumping mains and inverted siphons.

Theoretically it would seem as though the amounts of each size of sewer laid would decrease more or less uniformly with the size of sewer. In a general way, this is found to be the case, but there are certain peculiarities which appear to indicate a preference for sizes not based entirely upon theoretical calculation of capacity. For instance, 10 inches does not appear to be a popular size, the amount used being much smaller than the 12-inch in the case of vitrified pipe and somewhat smaller in the case of cement pipe. There is also a notable excess of 24-inch pipe, the amount being much greater than any other vitrified pipe larger than 18-inch, and any other cement pipe larger than 12-inch, except the 30-inch, the quantity of which appears to be unaccountably large.

The above peculiarities as well as others to be found in the large concrete, brick and segment block sewers, seem to result largely from a preference for even feet and half feet. For instance, of all pipes larger than 8-inch we find excess quantities for 12-inch, 24-inch, 30-inch, 36-inch, 42-inch, 48-inch, 54-inch, 60-inch, etc. That is, for each of these sizes in each class of material we find the amounts laid are greatly in excess of the amounts intermediate between these sizes. In the case of concrete and brick sewers, this may be explained by the fact that

more or less expensive forms are necessary for laying them and that such forms are more generally confined to these particular sizes, as to furnish the intermediate sizes also would add considerably to the total cost for forms. This, however, does not explain the same tendency found to exist in the case of vitrified and cement pipe, which can be purchased as readily of 27- or 33-inch as it can of 30, or of 10- or 15-inch as it can of 12.

SEWERS TO BE LAID IN 1924

In some respects it would be even more interesting to know the amount of sewers that will be laid this year. Probably few of these cities could give such figures definitely, even as late as June, and they were therefore asked to report what percentage they estimated as the amount of each class of sewer which would be laid this year as compared with the amount laid last year. The amounts reported varied all the way from none to forty times as much, but about one-fourth reported that they expected to lay about the same as in 1923, a number that the amount would probably be half as great, and about an equal number that it would be twice as great. Several reported that the amount would be "less" or "more" than last year. In these cases we assume, for the purposes of calculation, that the average of those reporting "less" would be 50 per cent. less and the average of those reporting "more" would be 50 per cent. more. Owing to the more or less indefiniteness and uncertainty of the information that was available, we have not gone into too great refinements in the calculation, but believe that the figures we have obtained reflect quite closely the average of the ideas as to 1924 work that were entertained by the city engineers who returned the questionnaires.

Using the various percentages and other statements, calculated and combined, we find that the engineers anticipate on the whole an increase of about 25 per cent. in the amount of vitrified pipe sewers that will be laid in 1924 as compared with that laid in 1923. The increase in the amount of cement pipe sewers has been calculated to be about 28 per cent.; that in the concrete sewers as about 28 per cent. In the case of the segment block, the estimates give 23 per cent. less for 1924 than 1923, the decrease being due mostly to the reports from Richmond, Va., Denver and Wichita, Kans. In the case of brick sewers, it was estimated that the amount this year would be about 48 per cent. less than last, the decrease being quite generally distributed among the cities.

By far the largest mileage of sewers laid will be of vitrified and cement pipe, especially the former. Examining the statistics for the vitrified pipe by divisions of the country (using the subdivisions employed by the Census Bureau) we find that the increase in vitrified pipe sewers anticipated for New England is about 10 per cent.; for the Middle Atlantic States, 20 per cent.; for the East North Central States, 35 per cent.; for the South Atlantic States, the East South Central States and the West South Central States, each about 15 per cent.; and for the Pacific States about 10 per cent. There is anticipated a 10 per cent. decrease in the West North Central States and a 15 per cent. decrease in the Mountain States.

Sewage Treatment Plants

Of the cities replying to our questionnaire, about 26% treat the sewage to a greater or less extent. Fifty-three per cent. of the treatment plants include Imhoff tanks and 22% include sprinkling filters. Four and one-half per cent. screen the sewage, with no additional treatment except that three chlorinate it afterwards. The use of chlorination in sewage treatment has been adopted by a number of cities recently, 20% of the total reporting using either liquid chlorine or hypochlorite—most of them the former.

Of those chlorinating, seven give the sewage no preliminary treatment, three of these cities being in Pennsylvania. Three screen only before chlorinating, five employ tank treatment, two use intermittent sand filters, and six give tank treatment and filtration or other treatment before chlorinating.

As indicative of present practice, it is interesting to note the plants that are now under construction or for which plans have been prepared. These plants are as follows:

Pine Bluff, Ark., has Imhoff tanks under construction. San Jacinto, Calif., is planning Imhoff tanks and intermittent filters; Victoryville, Calif., intermittent filters; and Whittier, Calif., sprinkling filters or activated sludge. Rochelle, Ill., is planning two settling tanks and sprinkling filters. Rochester, Minn., will build Imhoff tanks and filters this year. Carthage, Mo., has Imhoff tanks and sprinkling filters under construction. Syracuse, N. Y., has under construction plain sedimentation with continuous mechanical sudge removal. Oneida, N. Y., has under construction two settling tanks and a sludge tank. Kenmore, Ohio, has under construction sedimentation tanks and sand filters. Tulsa, Okla., expects to build two plants using Imhoff tanks and sprinkling filters and chlorinating.

Several other cities report that plans are now being prepared, but not specifying the type of plant; and others, that they expect to build a plant this year or next.

Highest Paid City Manager

On September 1st, C. E. Ashburner became city manager of Stockton, California, at a salary of $20,000 a year, which is believed to make him one of the highest paid city managers in the United States. (Norfolk, Va., also is now paying the same salary.) Mr. Ashburner was the first city manager in the country, the position having been created for him by Staunton, Virginia, in 1908. He goes to Stockton from Norfolk, Virginia, where his salary had been $16,000 a year.

Pensauken Sludge Digestion Plant

Sewage Treatment Plant Involving Separate Sludge Digestion and Mechanical Sludge Scrapers Built Jointly By Two Communities

By Norman C. Wittwer*

The sewage treatment plant now nearing completion at Pensauken, New Jersey, presents certain interesting features, some of which involve the latest developments in primary tank treatment of domestic sewage. When completed, this plant will consist of a three-compartment clarification tank preceded by bar screens, a sludge digestion tank, a pumping station and sludge drying beds.

When confronted with the problem of treating the domestic sewage from Pensauken township the engineers encountered a rather intricate problem. In the Philadelphia suburban districts, as is the case in other large communities, a veritable net work of small independent municipalities exists, each solving its own problems without regard to its neighbor, and often at a considerable sacrifice of public economy and efficiency. Sometimes it is possible to bring two or more of such neighboring municipalities together for a common solution of their problems. Often, however, their political differences are such that any attempt to promote co-operation meets with inevitable failure.

Pensauken township surrounds on three sides the borough of Merchantville, but from the standpoint of sanitary drainage both comprise but a single district. Merchantville constructed a sewage treatment plant in 1909 consisting of a septic tank, primary contact filters, and secondary intermittent sand filters. This plant gave excellent results at first, but in later years was at times so badly overloaded that increased capacity became imperative. The problem, therefore, became one of determining whether it would be more economical for Merchantville to increase its present plant capacity and for Penasuken to build a new and separate plant for its own sewage, or whether it would be more economical to build a new plant to treat the combined sewage from both municipalities. The latter course was found, upon thorough investigation, to be the cheaper and more satisfactory. After lengthy negotiations, an agreement was drawn up between Penasuken and Merchantville, according to which a new treatment plant was to be constructed of sufficient capacity for both municipalities. It was decided to construct this plant on the site of the present Merchantville plant, using such portions of the present plant as could be retained to advantage.

In the construction of the new treatment plant the following alterations and additions to the old plant have been made:

1. A three-compartment clarification tank has been constructed of sufficient capacity to treat the combined domestic sewage from both of the interested municipalities for a number of years to come.
2. The old septic tank has been converted into a sludge digestion tank.
3. A pumping station has been built as a part of the treatment plant to perform certain functions, which will be described later in this article.
4. Four of the eight old sand filter beds have been reconstructed for use as sludge drying beds and one of the old beds will be used for the purpose of

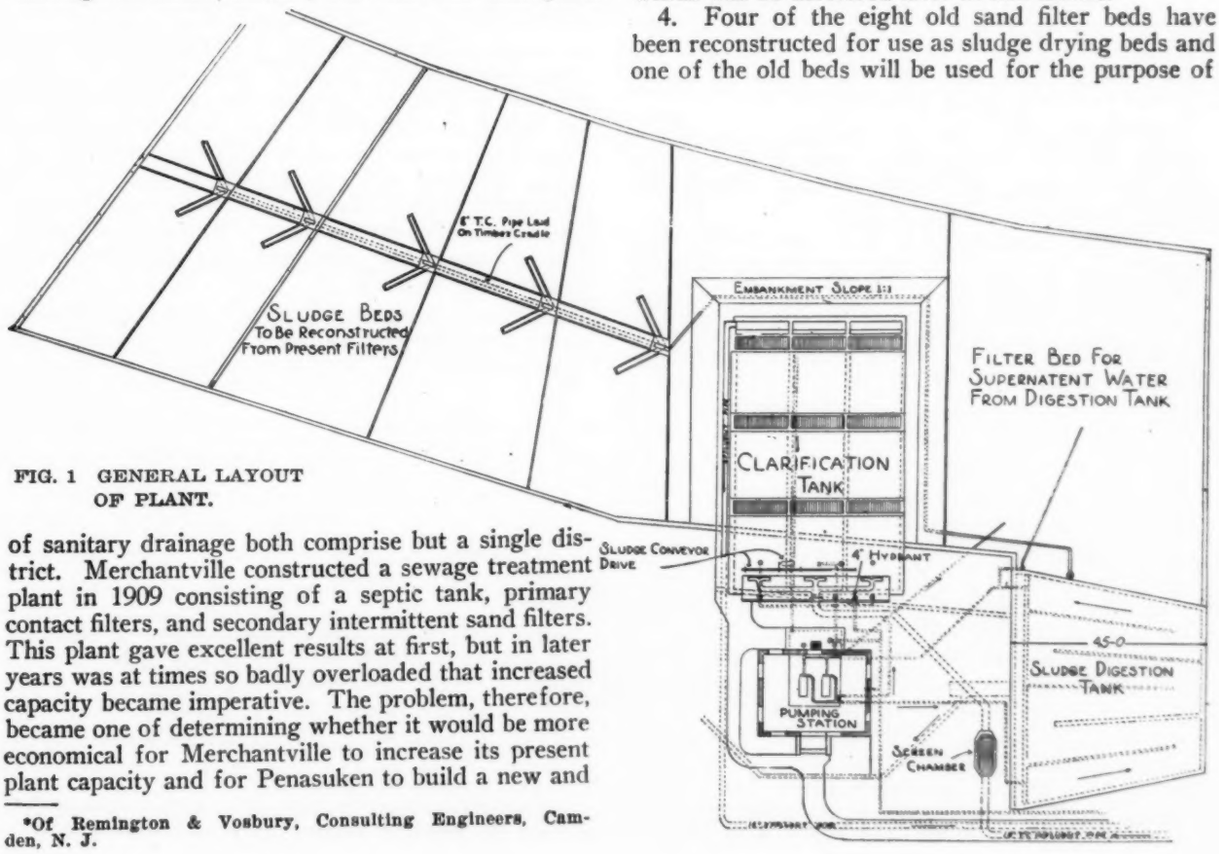


FIG. 1 GENERAL LAYOUT OF PLANT.

*Of Remington & Vosbury, Consulting Engineers, Camden, N. J.

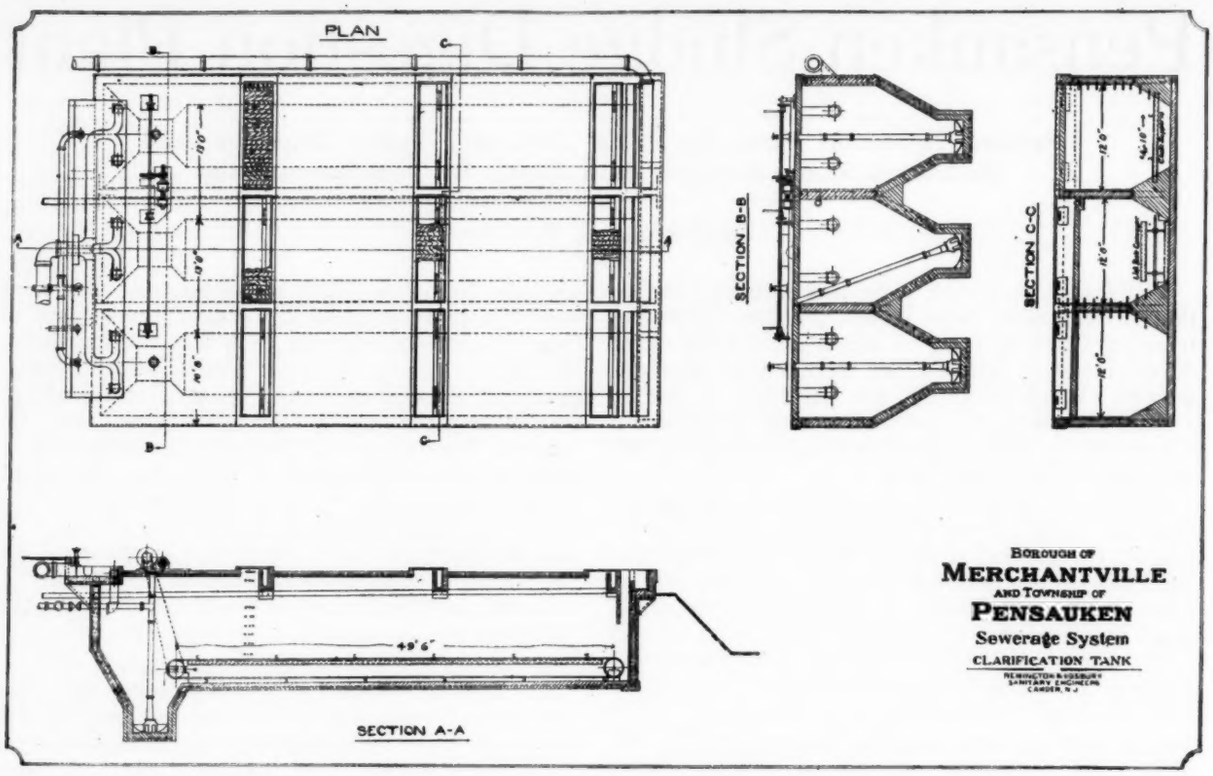


FIG. 2. PLAN OF CLARIFICATION TANK.

filtering supernatent water from the sludge digestion tank.

5. A 20-inch terra cotta outfall sewer 8,000 feet in length has been laid to convey the plant effluent to the Cooper river.

A general plan of the plant is shown in Fig. 1.

CLARIFICATION TANK

The clarification tank was designed as a unit to merely collect the settling solids from the raw sewage and not to retain the solids for any considerable length of time, nor to digest them.

As will be noted in Fig. 2, there are three entirely separate compartments, each functioning independently of the others. Each compartment is long, narrow and of a depth about equal to the width. This shape of tank is known to give a most efficient settling, and hence a high percentage reduction of solids.

In each compartment is installed a mechanical sludge conveyor, furnished by the Link-Belt Company, consisting of endless chain belts carrying steel channels which extend the entire width of the compartment. These channels will be slowly moved along the bottom of the tank, at a velocity of about fire feet per minute, scraping the settled solids into the sumps at the upper end of each compartment. From these sumps the solids will be pumped into the sludge digestion tank. It is expected that it will be necessary to operate the sludge conveyors only about fifteen to thirty minutes a day. The sludge will probably be pumped into the digestion tank at from two to three-day intervals.

Another interesting feature on the clarification tank is the inlet device. It has been found by experience that it is extremely difficult to divide a

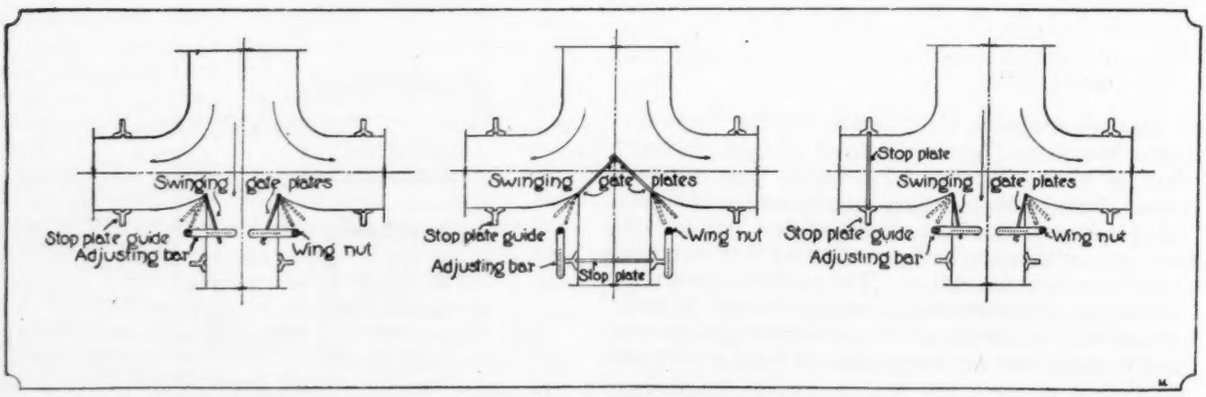


FIG. 3. INLET DEVICE, SET FOR 3-WAY FLOW, AND TWO DIFFERENT POSITIONS FOR 2-WAY FLOW.

gravity flow uniformly into several inlets, and often sewage entering one or more tanks is very unevenly distributed. The inlet device shown in Figure 3 is for the purpose of dividing an incoming stream of water into three equal parts. This can be done readily by throttling down the two swinging gates to a point where the flow passing through the center channel is equal to each of the flows diverted into the side channels. Also, if it is desired to temporarily cut one compartment out of service, the incoming stream can still be divided into two equal parts by the arrangement shown in Figures Nos. 3-B and 3-C.

As will be noticed by an examination of Figure 2, the tank is covered by a concrete slab roof. This was done because it was feared that an open tank, while just as efficient, might give off offensive odors and furnish cause for complaint in the residential district where the plant is located. With the covered tank the problem of floating scum and solids was anticipated by providing several scum channels across the tank. The scum will be admitted into the scum channels by removing the stop plates. The scum channels drain into a cast iron scum pipe, which in turn drains into the wet well of the pumping station. From here the scum will be pumped into the sludge digestion tank.

SLUDGE PUMPING STATION

The sludge pumping station is a very artistic building. It was designed with the idea of educating the people of the vicinity to the idea that a sewage treatment plant, instead of being an unclean spot to be avoided, can be a municipal institution the citizen is able to point to with pride. It is also known that a neat, well arranged plant will receive much better attention and operation than one in which convenience of operation and the aesthetics have been neglected.

There are two pumping units in the pumping station, both of which are electric motor driven. One is a 4-inch diaphragm pump, furnished by the Dorr Company, which is capable of pumping against a hydraulic head. This pump will lift the sludge from the sumps in the clarification tank to the digestion tank. It will also lift sludge or scum from the wet well to the digestion tank. The other is a 4-inch horizontal, centrifugal pump. It is to be used for the purpose of emptying the clarification tank compartments when necessary to make repairs or adjustments to the sludge conveyors. The suction and discharge piping of these pumps is entirely interconnected so that either pump may be used for any pumping duty, if so desired.

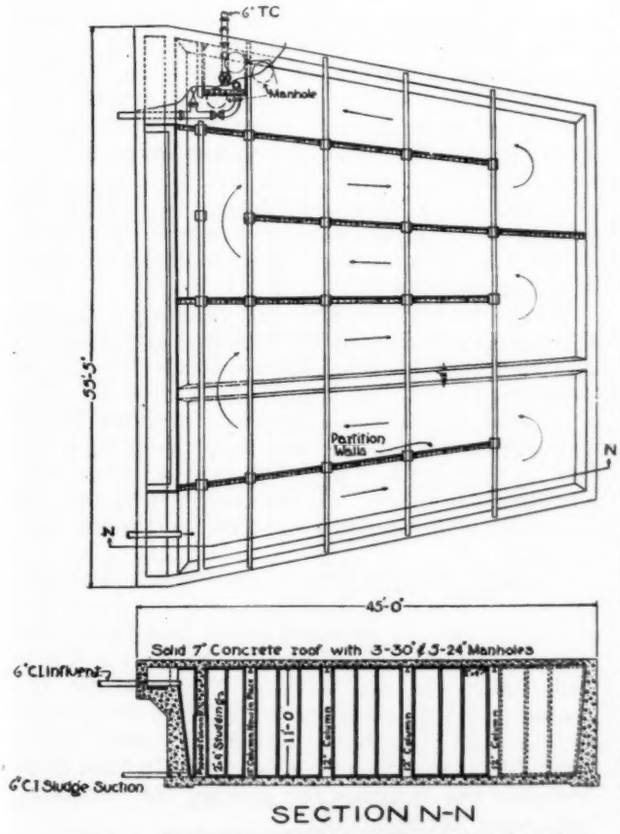


FIG 4. PLAN OF SLUDGE DIGESTION TANK.

SLUDGE DIGESTION TANK

Since the sludge digestion tank, as shown in Fig. 4, is a modification and reconstruction of the old septic tank, it was not possible to provide the arrangement for sludge digestion that would have been incorporated in a new tank. It is believed, however, that as reconstructed the digestion tank will show very good results.

As is well known, there are two fairly distinct stages in the process of sludge digestion. The first or fermentative stage is generally characterized by the foaming and boiling of the contents of the tank. Often whole layers of the sludge are lifted to the surface by the entrained gases and remain there as floating sludge until the gases manage to escape. The second, or putrefaction stage is less noticeable, and is marked by the absence of the large quantities of floating sludge which characterizes the first stage. An entirely different set of bacteria are at work in the second stage and change the offensive organic matter into a comparatively odorless and humus-like mass.

One of the latest types of sludge digestion tanks provides two compartments for the progressive treatment of the above mentioned stages of digestion. In the digestion tank as reconstructed for this plant, no attempt was made to provide separate compartments, but the path of travel was made so long from inlet to outlet that it is expected practically the same results as described above will be accomplished.

The outlet of the digestion tank, in addition to being connected directly to the drying bed, is connected by a cast iron pipe to the suctions of the pumps in the pumping station. This enables the withdrawal of digested and partially digested sludge from the digestion tank to be pumped back into the inlet end of the tank. Certain developments in Germany by Dr. Imhoff have shown that such a procedure will suppress putrid decomposition to some extent, and will also promote the biological changes of odorless decomposition so as to obtain properly digested sludge in the shortest possible time and in the smallest space.

The cost of the entire plant will be approximately

$50,000. The contractor doing the work is the U. G. I. Contracting Company, Philadelphia, Pa. The engineers on design and construction are Remington & Vosbury, consulting engineers, Camden, New Jersey.

Brick on Ohio State Highways

The Ohio State Highway Department has recently adopted the 3-inch vertical fibre lugless brick as the standard for the State highways, no 3½-inch or 4-inch brick to be used unless the traffic is extremely heavy or there are other conditions out of the ordinary. In the order issued by Chief Engineer Stellhorn of the Bureau of Construction, he states that the investigation made by the department indicates that if the foundation is ample, a 3-inch brick properly laid and filled will carry all modern traffic which a highway could be subjected to within the limit of the road laws.

Cleaning Filter Sand *

A new method employed at Salem, N. J., using caustic soda and soda ash, for cleaning badly clogged filters.

By C. H. Capen, C.E.†

The city of Salem, New Jersey, obtains some of the water for potable purposes from a surface source, Quinton Pond; the remainder is obtained from deep wells. The method of treatment of the surface supply consists of aeration, coagulation, rapid sand filtration and chlorination.

The raw water has a normally low alkalinity (1 to 21 P. P. M.), high color (35 to 120), and moderate turbidity (15 to 170). The use of soda ash is necessary at practically all times, but, even with careful adjustment of this and alum, the very finely divided suspended solids of a colloidal nature cannot be settled out. The turbidity increases after a heavy rain storm and the result is that large quantities of the suspended solids are carried over to the filters. The filtered effluent is satisfactory from a bacteriological and chemical standpoint, but due to the accumulation of mud the filters could not maintain their rated capacity for as long a period as when they were clean, even though they were washed more frequently than was necessary when they were first installed.

The filters, three in number, are rectangular with perforated laterals of the Harrisburg type. They have been in operation since January, 1920. Serious clogging, which doubled the amount of wash water used, led to the suggestion by this department that the filter sand be thorougly cleaned. The municipality asked for suggestions as to the best method to use and the one described in this paper was applied.

Experience at Little Falls.—In the autumn of 1922 the rapid sand filters of the Passaic Consolidated Water Company's plant at Little Falls, New Jersey, had become clogged with oil which it is believed was applied to the surface of the water up-stream by the various county mosquito extermination commissions. Immediate washing of the filter sand was necessary and as a result Mr. Frank Green, the superintendent of filtration at the plant, developed the use of a combination of caustic soda and soda ash to wash the sand without removal. The results were very gratifying and his description of the process led this department to believe that the same general method could be applied at Salem.

Difficulties Encountered at Salem.—The operators at the Salem plant did not exercise sufficient care in washing the filters, and the very fine mud accumulated in the beds to such an extent that it could not be removed by standard methods of filter washing. The wash water has an available pressure up to 15 pounds per square inch which is more than is usually required. The overflow edges of the wash water troughs are about 18″ above the sand, which is consistent with present standards of design. The finely divided solid materials could not be raised or moved up into these troughs even when so great a wash water pressure is applied that the sand is raised beyond a safe amount.

The accumulation of this finely divided mud formed a definitely clogged film of sand and mud about ½″ to ¾″ deep on all of the filters. Below this the presence of mud tapered off, but numerous mud balls were found at depths of a foot or more below the surface. Before treatment by the chemicals, the filters, even after a wash, were so clogged with mud that when the filter water was allowed to drain down below the surface of the sand, small pools of water remained on the surace on account of its inability to penetrate the mud layer.

When the filters were first installed a sample of filter sand was submitted to, and approved by, this department. This sand was used to fill in filters No. 1 and No. 3 and part of No. 2. The remainder of the sand supplied for filter No. 2 was not submitted and was much finer than the first lot. This filter therefore clogged more rapidly than the others. It was selected as the one on which the washing experiment should first be tried.

The area of each filter is 190 sq. ft. For this amount Mr. Green had found that about 175 pounds of caustic soda and about four times that amount of soda ash were required at the Little Falls plant. In the work at Salem, about 175 pounds of caustic soda and from 250 to 300 pounds of soda ash were used. Laboratory tests might have shown that a greater ratio would have been desirable but facilities for making the necessary tests were not available.

Procedure.—Prior to the time of starting the

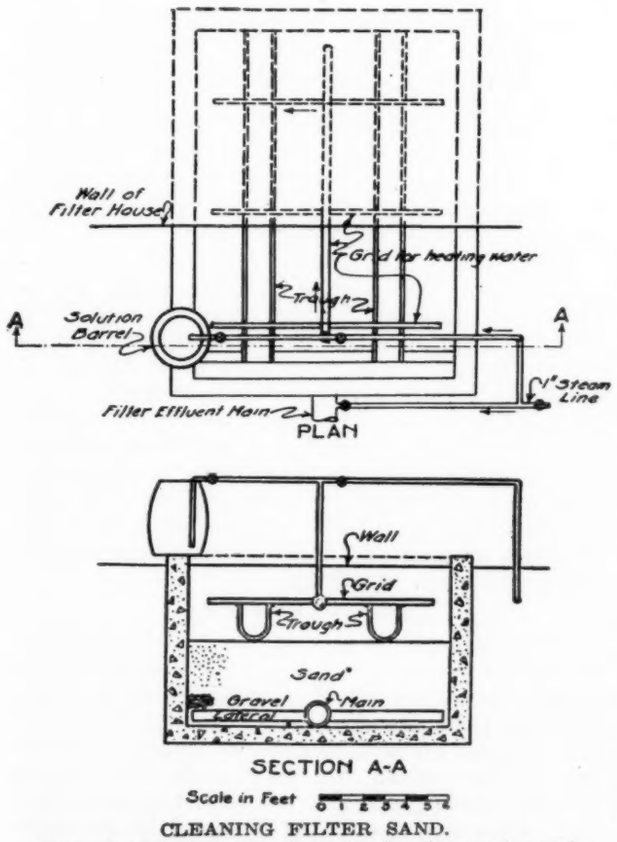
*From New Jersey "Public Health News."

†Assistant Sanitary Engineer, Bureau of Engineering, New Jersey State Department of Health.

washing process, a grid of ¾-in. pipes with small perforations at 6-in. intervals was placed over the surface of the sand, resting on the wash water troughs. A barrel with the bung removed was placed on the concrete sidewall of the filter for use in dissolving the caustic soda and soda ash. A 1-in. steam line was connected to the filter effluent manifold, the grid above the filter, and the barrel. The connections are shown in the accompanying diagram. The filter had been thoroughly washed with water and then water was allowed to flow over it to a depth of about 4 inches over the grid. The steam was then turned on.

The entire amount of commercial, fused caustic soda was placed in the barrel and water was added until the level of the bung hole was reached. Then the water was cut down so that just a trickle was coming out steadily, and the steam was turned on. As the caustic was taken into solution it was carried down into the water on top of the filter; about one hour was required to complete the process. Soda ash was added in the same way except that it was necessary to keep stirring it. The dissolving and addition of soda ash required about two hours.

When the addition of the solutions had been completed, the water on top of the filter was thoroughly stirred with paddles. After this, the filter waste valve was opened and the water was drawn down about a foot so as to obtain contact of the chemicals with the stand in the filter.



CLEANING FILTER SAND.
Arrangement of steam pipes for heating water and chemical solutions.

Later in the process it was drawn down about a foot more. After each period of withdrawal, water was admitted to the surface of the filter to cover the grid to a depth of 4 inches. After twelve hours of heating, the water on the filter had reached a temperature of about 175 degrees F.

Air Agitation Is Tried.—During the procedure. it was suggested to the superintendent that an agitation of the entire sand and water mass, such as obtained by an air wash, would be beneficial. He then mentioned that an air compressor owned by the municipality could be set up at the plant, and he was asked to install it. The air compressor was of the gasoline motor driven type used by contractors requiring a semi-portable machine. It's 1½" discharge was connected to the filter effluent manifold and it was operated at a pressure of from 5 to 10 pounds for a period of about 15 minutes. It was noticed that the agitation was very complete near the outlet end of the manifold but was practically negligible at the far end of the filter. This was probably due to the fact that the holes in the manifold were too large for the air pressure and permitted escape over too small an area. This air agitation was given about twenty hours after the start of the treatment and again just before the end of the process.

The Results Obtained.—After the solution had been kept in the filter at a temperature of 175° F. for about 40 hours the filter was thoroughly washed several times; over 50,000 gallons of filtered water being used. Observation showed a considerable improvement in the appearance of the sand, and the operators have since stated that the filter could be run longer after this treatment than at any time since it was first placed in operation. The results were encouraging, and it was decided to wash another filter by the same method.

Accurate Observations Made on Second Trial.—Filter No. 3 was next selected and preparations for the wash were made in a manner similar to that used for No. 2. In collecting samples of the sand a very prominent line of demarcation of the mud layer on top was noticed, and it was suggested that this be removed by hand before starting the washing process. Accordingly about ½" to ¾" of the top layers, including both mud and sand, was removed with a shovel. The total amount of material removed weighed about 400 pounds, of which about 250 pounds was mud. The moisture content of the removed material was about 50%.

The washing process and the amount of chemicals used were similar to that used previously with the exception that the air compresser was not available. After the sand had become heated it was allowed to remain with chemicals on it for a period of about 80 hours after which it was thoroughly washed several times; over 100,000 gallons of filtered water being used for this purpose.

Samples of sand, after the washing process, were taken and the sand was remarkably clean.

It was noted, however, that on the sections of the filter where the least wash water velocity existed, the mud piled up in well defined areas to a depth of about one inch. An attempt was made to remove this by washing the filter with a high velocity wash water, but this method was unsuccessful. It was therefore necessary to remove the mud by hand, which was relatively easy as it existed only in sections and could be readily taken up with a shovel.

In testing the sand a sample of 100 grams of dry material was taken and made up to 250 cc. with distilled water. The mixture was shaken thoroughly and the mud separated from the sand in settling.

The designation and tabulation of the results are as follows:

Source of Sample	*Condition*	*Per Cent Mud (Dry Weight)*
Top of sand to depth of 2½"	Before cleaning	10.4
Top of sand (muddy section)*	After "	2.15
Top of sand (clean section)	" "	0.5
Sand 4" below surface	Before "	3.2
Sand 4" below surface	After "	0.65

*No. 2 was taken from a section of the top on which some mud had collected as described above, before removal with a shovel.

Conclusion.—It is doubtful if better results could be obtained by removing the sand and cleaning it by the more common methods of washing. It is also probable that the chemical method is less expensive and easier, as it requires less labor and less time.

American Water Works Convention*

Account of the papers and discussions during the last two days of the convention

THURSDAY'S SESSIONS

The first paper Thursday morning was one by Thaddeus Merriman entitled, "Arrangement for Preventing Pollution of the Catskill Water Supply," in which were described the prevention of pollution by the various communities and villages on the shed by the construction of sewerage systems and other methods. Following this, "Watershed Protection" by the Pennsylvania State Health Department was described by Howard E. Moses, assistant chief engineer of the department, and several of the distict engineers. Coleman B. Mark stated that a forest reservation was established on the watersheds and that for the first mile above an intake no camps are allowed, while camps anywhere within the next mile must employ the can system for disposing of excreta. During the hunting season the water is always chlorinated. I. M. Glace stated that in six or eight cases in the northeastern part of the state waterworks superintendents had been made deputies for the purpose of watershed inspection, thus giving them some authority. L. D. Matter described the situation at DuBois, where the supply is obtained from three streams, on one of which is a large village. The water company's pipes had lost half the water by leakage, while filter plans had been made but not carried out. To remedy conditions, the reservoir dam was raised, which flooded out the worst polluting cases, and a dam was built on a small polluted stream, while property along the other stream was bought up. H. M. Freeburn referred to conditions on the Beaver river, the watershed of which contained 560,000 population, two-thirds of which was sewered. Referring to conditions in Virginia, L. H. Enslow, engineer of the State Board of Health, said that in that state the hunters were the chief danger. He had found no danger from B. coli if the water receives plenty of storage. Mr. Weston said that such a thing as an unpolluted watershed was fast disappearing, since the automobile was now penetrating all large sheds. The Pequannock watershed of the Newark water supply, which is entirely owned by the city, is traversed by a number of roads, and comfort stations are being established at most frequented points throughout the shed.

The report of the Committee on Industrial Wastes in Relation to Water Supply was presented by A. L. Fales. Written discussions of this report had been sent by Messrs. Stevenson and Crohurst. The former referred to the problem of phenol wastes. The latter stated that the Public Health Service had called a conference in Washington in an effort to secure cooperation by manufacturers in reducing pollution of water by industrial wastes. Nineteen phenol waste products plants exist in the Ohio river district and such plants were the latest to prove troublesome to the waterworks engineer. It was asserted that no method was known by which phenol can be removed from water after it has been admitted to it.

T. H. Wiggin, chairman, presented the committee report on "Testing of Waterworks Materials and Supplies," which was discussed by Messrs. Merriman, Flinn, (who especially considered brass and galvanizing), L. P. Wood, C. P. Hoover, John R. Baylis (who referred especially to sulphate of alumina) and F. W. Green. The last-named stated that it had been reported that a million dollars was being appropriated (donors not named) for carrying out a general investigation of colloids, which should be of the greatest interest and value to those engaged in the purification of water.

FRIDAY'S SESSIONS

Friday morning's session opened with a paper, brought forward from the Thursday afternoon program, by Scotland G. Highland entitled, "Weather Bureau Data at Pumping Stations." Mr. Highland described at some length the benefits of the Bureau and its records, the various stations throughout the country, the operators, etc. He stated that in the British Isles the rainfall stations range one for every 22 square miles.

*Continued from page 199.

Among other records taken by the U. S. Weather Bureau are those obtained from soil thermometers (which are of interest in connection with the freezing of watermains), wind velocities, etc.

Wellington Donaldson then read a paper entitled, "Action of Water on Service Pipe," in which he made extended references to tables concerning service pipe published in "PUBLIC WORKS" two years ago. It was his opinion that lead poisoning from lead service pipes is more frequent than is reported. Lead is removed from lead service pipes by both erosion and solution, the solvency of the water depending upon its acidity. In discussing the paper, Mr. Diven stated that it was a very difficult matter to find out just what water is dangerous to use with lead services. As to cast-iron services as a preventive of corrosion, they were removing cast-iron services in Troy eighty years old that had been laid uncoated and were badly corroded. F. N. Speller stated that oxygen concentration was a very important factor in lead corrosion and that such corrosion does not depend on CO_2, as is often stated. He presented on the blackboard a table showing the relative importance of different features in corrosion in connection with different waters. For an alkaline water, these features in order of their importance were: Film, oxygen, pH, velocity and temperature, and composition. In the case of neutral waters, the order would be: Oxygen, velocity and temperature, film, pH, composition, over-voltage. For acid waters the order would be: pH, over-voltage, oxygen, composition, velocity and temperature, and film. Weston stated that oxidation in Brookline had brought about nearly complete saturation with oxygen and had been followed by much trouble with the house plumbing, tin lined brass pipes being the only kind that would stand. In some cases, at least, 0.1 parts per million of lead had seemed to affect patients. He was in favor of cement-lined services.

"Pumping Station Betterments" were reported upon by Leonard A. Day. He did not favor steam turbines for auxiliary station equipment, referring to one that had been found to lose 25% of its efficiency in two years through cutting and clogging of the turbine buckets by steam, due to impurity in the boiler water carried over with the steam. "Operating Experiences and Economy of a Diesel Engine-Driven Pumping Station" were discussed by P. DeW. Vosbury from the point of view of the designing engineer. A great advantage of this type, he said, was its efficiency independent of the smallness of size. The only attention needed is to grind the engine valves every six to eight weeks. The engines can be operated by untrained men. They are sensitive to sudden changes of load. Discussing these two papers, Mr. Chester referred to one case in which he had found it very difficult to get an engineer for a gas engine when the regular engineer had been laid up with sickness. Since then, that company had required that the waterworks superintendent must be able to run the engine in such an emergency. While a gasoline engine might cost little for maintenance at first, he believed that after five years, maintenance would cost more than operation. Contrary to the experience of Mr. Day, he found little loss of efficiency in steam turbine plants. Mr. Gibson emphasized the importance of reliability in all the features of a waterworks pumping plant, stating that economy and efficiency were second to this in importance.

In the afternoon W. S. Cramer, in a paper entitled, "Keeping an Antiquated Plant in Tune," urged superintendents to take more pains with such facilities as they had at hand and use the old plants to the best advantage until new could be obtained. He cited one case where the use of a CO_2 recorder, recording gauges, and pyrometers used in a small plant resulted in a saving of 20 to 25% of the coal. Some plants had found it well worth while to pay a bonus to the firemen based on the duty they get out of the coal handled. One case was cited where a 300-horsepower gasoline engine was secured as a standby and also used while replacing a wornout boiler. The engine cost $18,000, but saved this amount by permitting changes to be made in the plant. One aid in keeping the plant up to its maximum performance was that students at the university each year made a test of some part of the plant.

Following this paper a discussion of the question box was taken up. Mr. Gibson told of increasing the station duty at the Charleston plant from 35 million per hundred pounds of West Virginia coal to about 70 million, this including the low-lift pumps and also lighting and other service about the station. One of the changes made was putting Dutch ovens on Sterling boilers.

Mr. Diven suggested purchasing pipe in winter rather than waiting until summer, saying that it was not only cheaper but, where it had to be laid across country, the hauling over the snow is cheaper. Another member, however, offered as an objection that the bond issues for purchasing the pipe were not often available before spring.

Geo. R. Taylor told of an experience at Carbondale where synura had been troublesome in winter when the reservoir was frozen over and, therefore, difficult to treat with copper sulphate. To effect such treatment, holes were cut in the ice, which was 18 inches thick, at intervals of 25 feet. A steam boiler was used to dissolve the copper sulphate and by means of a hand pump it was discharged through hose which was inserted into a hole and, by means of poles, moved about under the ice as far as possible from the hole. The treatment cost $400, whereas it cost only $150 in summer. Complaints concerning the taste ceased in about 72 hours. It was his experience that one pound of copper per million gallons will cure synura. Another member recommended controlling algae by prevention by using copper sulphate three times a year, generally in May, July and September. Mr. Gibson said that in Charleston they used copper every day, applying 40 pounds a day above the filter.

Concerning flushometers, Mr. Diven believed that it was very desirable to adopt regulations controlling their use, and it was moved that a committee be appointed to investigate and report on the use of them. William H. Buck described a device employed by him in testing meters, which was followed by a general discussion of this subject.

"Leadite" was the subject of a number of comments. Mr. Buck said that he had laid many miles of pipe with leadite and had had only one bad joint, while another member reported having had eleven bad joints out of seventeen laid. Stephen H. Taylor has had 15 miles of such joints underground for four years and found them very satisfactory; and Mr. Diven and others had had favorable experience with it.

One of the members then described a method devised by him for cutting off a 48-inch pipe on the work. By use of a drill operated by an air compressor, fourteen holes were drilled through the pipe around the circumference along the line to which the pipe was to be broken, and wedges were driven into the holes, when the pipe broke off true around the entire circumference. Another member narrated employing much the same method in cutting off a 16-inch pipe in an 8-foot ditch which projected from a masonry wall; ⅜-inch holes being drilled four inches apart around the circumference and the holes being connected by a light cut made with a diamond point, after which wedges were used as above.

Some members then described methods employed in locating leaks. One described his experiences with the geophone, saying that it took time to become familiar with it but that he now uses two to great advantage. Two other members also spoke favorably of the geophone and Mr. Heffernan of this and of the Darby leak locator.

Some features of meter testing were then discussed. One member recommended the use of a portable test meter which could simply be attached in the cellar and the measured water spilled into a laundry tub.

Private fire protection services were discussed by H. A. Burnham. It was suggested that the size of the connection be used as a basis of charge. In Charleston a charge of $50 is made for services larger than 6-inch.

This meeting and the convention closed with a more or less general discussion on the subject of water shortage and the laying of service connections for vacant property, which latter practice was considered successful in Savannah, where no leaks had occurred and where it was a general experience that building followed shortly after the paving and thus most of the connections were soon put to use.

Sewage Protects Piles

In a recent discussion on piles before the Engineer Society of Western Pennsylvania, Maxwell M. Upson, vice-president and general manager of the Raymond Concrete Pile Co., said: "The sub-structures of the piers at New York proper have not been affected to any material extent" (by the teredo navalis and limnoria terebrans) "for the reason that the sewage has apparently given the teredo and limnoria indigestion or some other equally effective malady which causes them to seek other abodes. The teredo has manifested itself in the harbor both in and around Staten Island and in Jamaica Bay."

Standard Hose Couplings

Reference has been made by us several times during the past ten years to the desirability of the universal adoption of a standard fire hose coupling which has been advocated by most organizations and societies interested in the subject of fire protection and water supply.

Probably the first action looking to a standard which led to any results was the adoption of a standard in 1890 by the National Association of Fire Engineers. Some progress was made, but interest waned and in 1919 the National Board of Fire Underwriters made an intensive campaign in order to revive it. Up to date more than 700 cities and towns have not only decided to adopt the standard, but have carried out the practical steps necessary to put it into working order, while numerous other cities, towns and counties have officially decided upon its adoption, and the State of Oregon has made its use mandatory and a similar measure has been reported in the Massachusetts Legislature.

In spite of this progress, however, about three-fourths of the 8,000 cities and towns in the United States having fire protection still have non-standard threads. Lack of interchangeable couplings was a large factor in the great loss by fire in Salem, Mass., in 1914, Paris, Tex., in 1916, Augusta, Ga., in 1916, Atlanta, Ga., in 1917, Thomasville, Ga., in 1918, Mobile, Ala., in 1919, Pocomoke City, Md., in 1922 and Grimes, Ia., in 1923; also in smaller towns such as Rising Sun, Md., in 1921 and Farmington, Conn., in 1923.

The railroads are in a position to especially appreciate this problem in providing means for protecting their property in the different towns through which they run. The Seaboard Airline Railway has to carry in stock 29 different non-standard hose couplings together with special fittings or adaptors to enable each of these to be connected with the standard form of coupling.

An important recent development is the national agreement on a complete set of tolerances or limits of accuracy of manufacture, as approved by the American Engineering Standards Committee. Heretofore manufacturers have worked almost entirely from samples of couplings submitted by the purchasing authority instead of by the use of accurately made gauges. This has been a prolific cause of non-uniformity, since old couplings, hydrant nipples and caps are not reliable as test pieces owing to wear and corrosion.

The standard as thus defined and approved by the Standards Committee is endorsed by the National Board of Fire Underwriters, National Fire Protec-

tion Association, American Society of Mechanical Engineers and American Waterworks Association. Any of the bodies mentioned can probably furnish to interested cities copies of a publication issued for the use of fire chiefs and superintendents of waterworks explaining the methods of securing complete interchangeability through the use of inspection gauges. Another has been prepared for the guidance of manufacturers.

Cost of Large Gate Valves

Bids were opened on June 17th by the city of New York for nearly $200,000 worth of gate valves varying in size from 6-inch to 48-inch. The contract includes fifty 6-inch gate valves, twenty-two 12-inch, forty-six 20-inch, seventeen 24-inch, ten 30-inch and thirteen 48-inch. Three bids were received for these valves. Those for the 6-inch varied from $35 to $62.68 each, averaging $50.89. Those for the 12-inch valves ranged from $395 to $652, averaging $555. Those for the 20-inch ranged from $895 to $1499, averaging $1278.67. Those for the 24-inch valves ranged from $1520 to $2091, averaging $1883.67. Those for the 30-inch valves ranged from $2195 to $2765, averaging $2488.33. Those for the 48-inch valves ranged from $3890 to $4727.50, averaging $4371.50. Bids were also received on thirty-five 6-inch fire hydrants, the minimum being $66 and the maximum $75, with an average of $69.12.

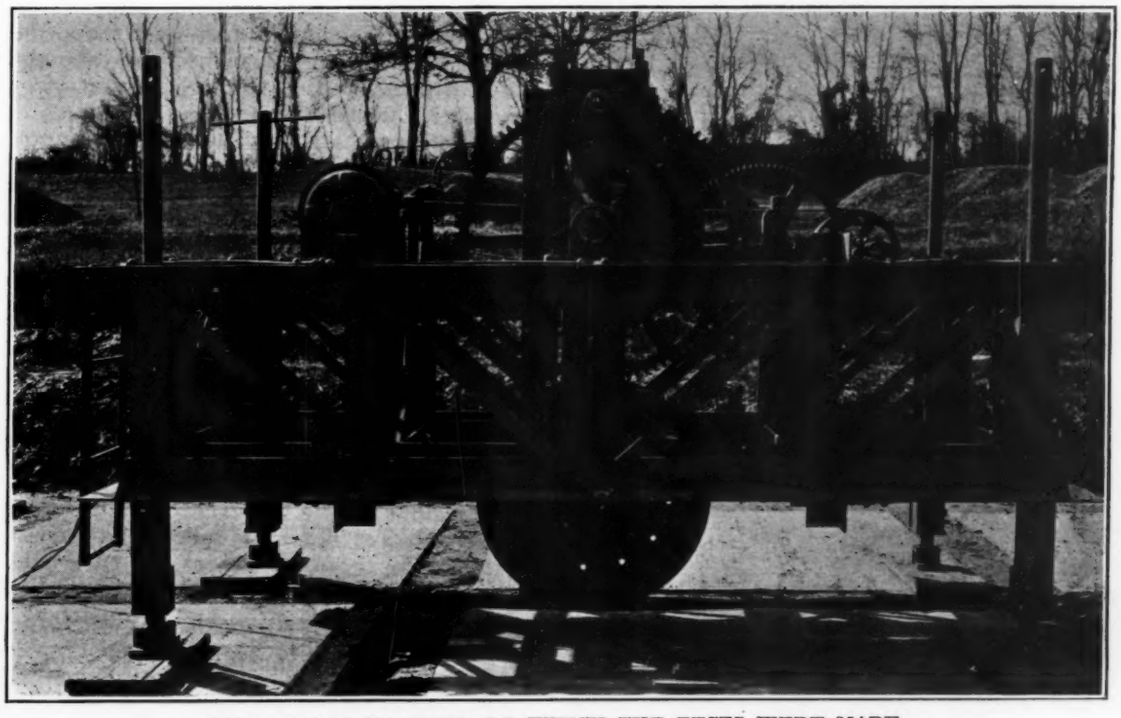
Impact on Concrete Pavements

Tests made by the Bureau of Public Roads, using a specially devised machine, and conclusions drawn from them

A study of the effect of motor truck impact on concrete pavement slabs was begun by the Bureau of Public Roads four years ago. Recently the Bureau has completed tests on a series of slabs more comprehensive than former ones in its range of types. Some of the results are erratic, but in the main they are quite consistent and certain indications are apparent throughout the test.

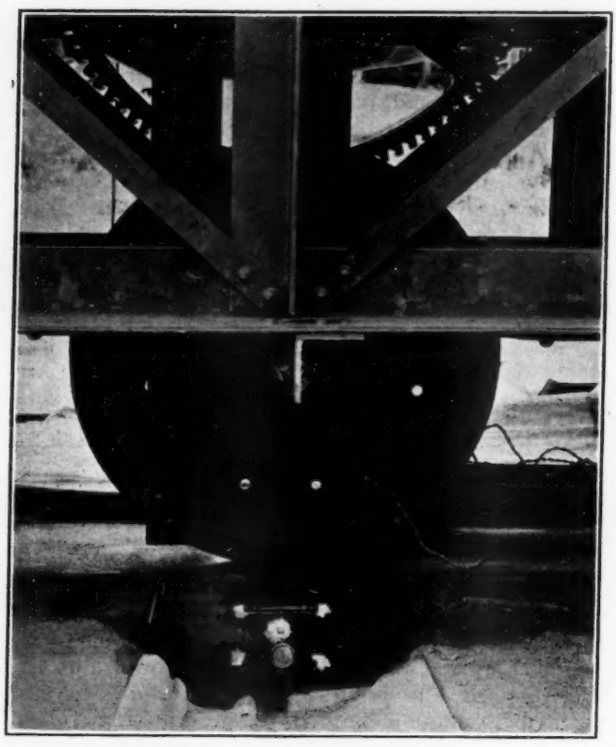
HOW TESTS WERE MADE

The conclusions are stated in terms of maximum impacts delivered by different weights of motor trucks. The maximum impact values are such as would be expected under conditions of high speed and rough service. Failure is assumed to have occurred when cracking takes place. In making the test, a specimen 7 feet square was laid on a moderately plastic clay subgrade, wet portions having water standing almost level with the surface and dry portions being merely damp with capillary moisture. Repeated impacts, increasing to the maximum



THE IMPACT MACHINE, BY WHICH THE TESTS WERE MADE.

which caused cracking, were applied at the corner and at the center of one edge by an impact machine dealing blows closely resembling impact of motor trucks. Rolling loads were not applied. No impacts were delivered at the centers of the slabs.



CLOSE-UP OF IMPACT MACHINE.
Set-up of apparatus for the edge test, showing graphic strain gauges in top and bottom of the concrete base, deflection dial, thermometer in bituminous material, and accelerometer mounted on shelf below axle.

SET-UP OF STRAIN GAUGES AND DEFLECTION DIAL FOR THE EDGE TEST.
Topeka top beginning to crack.

An attempt was made to reproduce two subgrade conditions—a dry, well-drained type and a thoroughly saturated one. One hundred and twenty-four slabs were laid, embracing about forty different types. Each slab was laid in duplicate and more important types were placed on both dry and wet subgrades.

The types of slabs may be divided roughly into five groups: 1. Plain concrete. 2. Reinforced concrete. 3. Concrete bases and bituminous tops. 4. Bituminous bases and bituminous tops. 5. Macadam bases and bituminous tops. The report recently published by the Bureau deals with concrete pavements only and not with those having bituminous tops on macadam and bituminous bases. The behavior of such pavements is materially different from that of concrete slabs or concrete bases with bituminous tops.

After concrete bases had cured for a year, the bituminous tops were laid by contract under the supervision of the Bureau. Four-inch and six-inch concrete bases on wet subgrade sections were cracked in rolling bituminous tops, the lean mixes being badly broken up. This eliminated several very interesting sections from the tests, but it is worth noting that 6-inch 1:1½:3 concrete bases were cracked in construction where a fairly bad subgrade condition obtained, while 4-inch base of the same mix withstood the same roller loads undamaged on a good subgrade.

The impact machine, which is shown in the accompanying illustration, consisted essentially of a rear wheel of a motor truck fastened solidly to the middle of a truck spring and so arranged that it could be raised to any desired height from the surface under test and dropped suddenly. Power was furnished by an electric motor which operated through a train of gears, raising the wheel by means of a pair of cams. The whole machinery was suitably mounted on a framework of structural steel.

In testing a slab, the machine was set up so that the wheel was over the point where the load was to be applied and by means of corner screws the machine was set for a very low drop. It was possible to adjust the mechanism for any desired sprung weight and unsprung weight, as well as height of drop. Three to five blows were delivered at one elevation and the machine was then raised slightly and three to five more blows given, and this was continued until the data indicated that the maximum impact had been delivered that was possible with the weight of truck assumed to be represented by the machine. If the slab had not then failed, the loads were increased to those of a heavier truck and the test repeated. Load conditions corresponding to those of a 2-ton, 3-ton and 5-ton truck were used.

CONCLUSIONS

The following conclusions were drawn from these tests by the engineers of the Bureau:

The resistance of the road slab depends in part upon the supporting value of the subgrade. A subgrade of high supporting value materially increases the resistance to impact.

Impact resistance of rigid slabs varies neither directly as the depth of the slab nor as the square of the depth but as some power less than two.

In general, plain concrete slabs show no more resistance to impact delivered at the edge than to impact delivered at a corner.

Transverse cracks and longitudinal cracks near the sides of a road slab may be caused by impact delivered at the edge of the slab.

Plain concrete of 1:3:6 mix offers resistance to impact ranging from about 60 per cent to 80 per cent of the resistance of plain concrete of 1:1½:3 mix. The lean mix also shows more variation in strength.

Reinforcing steel in concrete slabs, if present in sufficient amount and so placed as to receive tensile stress, adds to the resistance of the slab to impact.

Reinforcing steel placed longitudinally and transversely in equal percentages is more effective in preventing corner failures than the same amount placed in one direction.

For a given percentage of steel, small deformed rods closely spaced seem to be more effective than large deformed rods widely spaced.

There is very little evidence of cushioning by bituminous tops on concrete bases at temperatures of 90° F. or less.

In these tests there was no evidence that bituminous tops on concrete bases added to the slab strength of the base, with the possible exception of the 4-inch and 6-inch bases on the dry subgrade.

Laid on the wet plastic subgrade none of the unreinforced slabs was capable of resisting impact at the edge or corner equivalent to that of a 5-ton truck; only the 8-inch, 1:1½:3 slabs and the 2-inch Topeka tops on 8-inch, 1:1½:3 bases resisted edge or corner impact equivalent to that of a 3-ton truck; all unreinforced slabs of lesser thickness failed under edge or corner impact less than that of a 2-ton truck.

Laid on a dry subgrade, the 8-inch plain concrete slabs of 1:1½:3 mix and the 8-inch edge thickness, unreinforced, 1:1½:3 bases with 2-inch Topeka tops resisted edge and corner impact equivalent to that of a 5-ton truck with a safe margin; no other slabs were capable of resisting the 5-ton truck impact even under the favorable conditions of dry subgrade support. A section of 6-inch plain concrete base, 1:1½:3 mix, with a 2-inch Topeka top resisted the edge impact of a 3-ton truck; no other slabs of lesser edge thickness, laid on the dry subgrade, were capable of resisting impact greater than that of a 2-ton truck.

None of the systems of steel reinforcing tested added sufficiently to the strength of a 6-inch 1:1½:3 concrete slab to enable it to resist the edge and corner impact of a 3-ton truck when the slab was supported by a very wet, plastic subgrade, nor to resist the edge or corner impact of a 5-ton truck when the slab was supported by a dry subgrade.

In some of the tests there was evidence that while the presence of the steel did not assist greatly in preventing the formation of the first crack it did prevent the development of the crack and the further failure of the slab.

A study of the data leads to the conclusion that fabric reinforcing of the type used in these tests at or near the center of a road slab does not appreciably increase its resistance to impact. Where slabs were reinforced with deformed bars, they showed a definite increase in strength, particularly in the corner tests where the steel was in a better position to take tensile stress. In the corner test, the slabs having 1% of steel show about 13% more strength than the slabs having 0.5%. A study of the behavior of the breaks after failure leads to the conclusion that, for a given percentage of steel, small rods closely spaced are more effective than large rods widely spaced. Along the edges the reinforcement was placed in the upper part of the slab. As a result, it offered little resistance to the formation of the first crack but a marked resistance to further failure. In no case was it possible to develop the crack through the top of the slab, although a complete transverse crack showed at the bottom. Additional very high impacts failed to break down this resistance in the case of the rods, but not of the mesh reinforceed slabs.

Topeka top on concrete slabs proved to be extremely tough and resistant to cracking, even more than sheet asphalt with a binder course. Even after the failure of the concrete base, the bituminous layer bridged the crack and withstood the impact, materially reducing the destructive effect of the succeeding blows. On the dry subgrade, where the foundation support was good, these Topeka tops withstood very severe punishment with little deformation or cracking.

Maintenance Contracts for City Paving

The advisability of discontinuing the maintenance provisions in paving contracts by New York City was taken up by the Board of Estimate of that city some time ago, on the suggestion that it might be cheaper for the city to perform the work with its own forces. In discussing the matter the board said:

"The only element unknown to the contractor which enters into his estimate of the maintenance charge is that of changing traffic conditions, for which he must undoubtedly allow a substantial factor of safety. This may in some cases, as the Comptroller has pointed out, result in an excessive allowance in his bid for the maintenance work, but experience shows that the bids are based on the average maintenance cost of many streets so that losses are sustained on some contracts and profits on others."

The board believed that a contractor who must maintain a pavement for several years "will not be as likely to slight essentials which would

cause a heavy maintenance expense as would be the case if his responsibility ended with the laying of the pavement."

An engineering committee appointed to study the subject decided that it is very closely related to traffic regulation and that "before any final conclusions could be reached it would be essential to regulate the character, weight and speed of vehicles in order that pavements might be designed and built to meet certain definite traffic standards."

Avalon's Alcoholic Drink

A rather unusual, but not a surprising, incident occurred in the latter part of the year when the prohibition agents, while raiding an illicit distillery near Elkridge, dumped the mash into a tributary of the Rockburn branch. This stream is used as an auxiliary supply for the Avalon water filtration plant and also for feeding an ice pond used by two private residents of Lawyer's Hill. The dumping of the mash in this stream caused a highly alcoholic taste in the filtered water supply, which was eliminated soon after, by cutting off the Rockburn Branch from the supply.

Such experiences as these frequently have a beneficial effect, although the immediate one may be detrimental. They indicate the methods by which a recurrence of such troubles may be avoided. This Bureau availed itself of the opportunity, therefore, to supply the prohibition department with a copy of the Maryland water-sheds and requested the local prohibition director to make every effort to prevent the wastes from illicit distilleries, when discovered, from being emptied into public water supply streams.

(From the 1923 annual report of Abel Wolman, chief engineer of the Bureau of Sanitary Engineering, Maryland State Department of Health.)

Lakeland to Purchase Incinerator

Lakeland, Fla., in June voted a bond issue of $1,069,000, by a majority of more than six to one, $20,000 of which is to be used for the purchase of an incinerator, and the officials state that they expect to install "one of the most modern and up-to-date in the State of Florida." Lakeland has a population of about 18,000 and believes that the action in passing a bond issue of this size is a matter to be proud of.

The remainder of the issue is to be used for developing public parks around the nine lakes within the city, purchasing a lot on one of them and building thereon a new city hall and municipal auditorium, purchasing and equipping an athletic field (presumably for the use of the Cleveland "Indians" in their winter training), for a municipal abattoir, two additional fire stations, a colored hospital, a jail and a comfort station.

Paving Brick Consumption

With the start of the season's paving work in May, the shipments of paving brick during that month showing a favorable development, reports from 60% of the industry showing that these plants were working at 93% of their normal capacity during that month. The production was 26,569,000, the shipments 24,507,000, and the unfilled orders 100,242,000 on the last day of May.

Ohio led all states in consumption, using 3,148,000 on city streets and 2,727,000 on county highways. Kansas was second, Oklahoma third and Illinois fourth with 2,425,000 for city streets.

Minimum Specifications for Highway Engineering Positions

The National Research Council, through its Advisory Board on Highway Research, has recently issued as Bulletin 45 a report on "Minimum Specifications for Highway Engineering Positions," which was prepared by a special committee appointed by the American Association of Engineers, with the official cooperation of the United States Bureau of Public Roads and of several state highway commissions and municipal bureaus.

The report lists the essential qualifications for the filling of seventeen typical highway engineering positions. It also presents 117 actual problems which have arisen in the everyday work involved in carrying out the duties of the various positions. It is intended to be of practical service to those concerned with the selection, assignment, promotion, transfer or training of highway engineers. Copies can be obtained from the Washington office of the National Research Council.

California Two-Way Highways

Of about 150 miles of paved highways in Contra Costa County, Calif., 36 miles are of what is known as two-way or two-slab construction. This consists of two concrete roadways separated by an intervening strip of asphalt macadam. The two parallel concrete roadways are each 8 feet wide, and the asphalt macadam strip between them is 4 feet; while there is a 2-foot oil macadam shoulder on each outer edge of the road. This makes a 24-foot roadway, using three different types of material.

The concrete slab is laid 5 inches thick with a slope of 1 in. in 8 ft., the mix being 1:2:4. The asphalt macadam strip is made 5 inches thick and crowned 2 inches. The two concrete roalways are finished first, then the inner edges of these are cleaned and sprayed with hot asphalt so as to make a watertight joint with the asphalt macadam.

Of the 36 miles, 7 miles of the concrete roadways are provided with inverted concrete curbs, most of them extending 12 inches below the bottom of the slab, on the outside edge of each roadway. On curves where the roadway is super-elevated, an additional curb is placed on the inner edge of the upper roadway.

Kansas Public Utilities

The cities of Kansas own and operate 255 of the 261 water systems in the state; also 140 electric light and power plants and 97 distributing systems. The cities of that state also own all of their sewer systems, 147 in number. Of the 116 gas plants in the state only 7 are municipally owned, but this is believed to be considerably more than is found in any other state.

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Prospect for Sewer Construction

We have discussed elsewhere in this issue the probable amount of sewer construction this year as compared with last, based upon reports from nearly 500 city engineers in all sections of the country. These engineers represent cities of all sizes and, while they constitute perhaps only one-third of all that might be expected to construct sewers, the average of these would seem to be fairly representative of the communities as a whole.

These reports indicate a somewhat greater amount of work this year than last, although it is of course possible if not probable that the actual performance will fall somewhat short of anticipation. In spite of the natural optimism often displayed by such reports, however, it is probably safe to say that as much work will be done this year as was done last.

One of the interesting details brought out by the statistics collected is the fact that brick sewers are still being built in considerable quantity, about 25 miles having been reported as built in 1923. However, the anticipation of the informants was that not much more than half of this amount would be built in 1924. Brick sewers seem to be laid chiefly by the larger cities such as Denver, Chicago, St. Louis, Omaha, Cincinnati, Pittsburgh, Nashville, etc.

The great preponderance of small pipe—12-inch diameter and less—indicates that most of the systems built or extended last year were sanitary sewers only. In fact, most cities except some of the very largest and of those discharging into tidal waters have adopted the separate system, and this system is required by the boards of health of many of the states, because of the great advantage of the separate system where the sewage must be treated; and state boards are requiring most communities nowadays to either build sewage treatment plants at once or provide for their installation later on.

Standardizing Manholes

The Department of Commerce, which has brought about the standardizing of many products of all branches of manufacture in this country, has recently turned its attention to manhole castings such as are used in connection with sewers, telephone and electric conduits and occasionally gas and water mains. At present some of the lighting and telephone companies have standardized their specifications and sizes, but few other companies have done so, and there are believed to be no standards recognized by any of the municipal departments.

Probably most municipalities have adopted the practice of having manhole frames and covers made by local foundries, which provide themselves with patterns for the local designs, which patterns cannot be used for furnishing castings for any other cities. The result is that there is no competition, since any outside foundry would have to have patterns made especially for any contract that it might obtain and charge the entire cost of the patterns against the price on this one contract. This permits the local foundry to reimburse itself for nearly the entire cost of the patterns on each set of castings furnished. If a standard were adopted, any foundry could, by using one set of patterns, furnish castings for any city, and there would thus be general competition and a lowering of cost.

Another phase of the problem is the relatively low grade of material often used in manhole construction. With the heavy wheel loads now passing over our pavements, the breakage in manhole covers is be-

coming a serious matter in a number of cities, even more from the inconvenience, danger and loss to traffic than because of the actual cost of replacing the cover. It is believed, therefore, that there is great need for uniform specifications calling for a better grade of material than is now frequently obtained.

The development of standard sizes and standard specifications will require the co-operation of municipal engineers and lighting and other public service companies, and it is the hope of the Department of Commerce to bring about a conference and agreement of representatives of the several classes interested, including the foundrymen themselves.

Municipal Bond Sales

The six months ending June 30th saw the sale of more than eight hundred million dollars of state and municipal bonds, according to the Daily Bond Buyer of New York. The highest individual offering was the New York City loan for a little over 67 million dollars. During the month of June alone, the sales totalled $265,439,834, which is more than 50% higher than any other June. The next highest total sales for the first half of any year was $734,157,276 in 1922.

Auto Taxes for Cities

Discussing the subject of street repair before the International Association of Street Sanitation Officials, Theodore Eichhorn, superintendent of streets and public improvements of Erie, Pa., stated that his city and undoubtedly others in the state were suffering under the Pennsylvania State law which provides that, once a pavement has been constructed, whether of macadam, stone block or any other material, the city must keep it in repair for all time to come, the cost being paid out of the general fund. Erie has found it practically impossible to get enough revenue to replace its wornout pavements as rapidly as they should be.

Mr. Eichhorn believes that municipalities should receive a portion of the auto tax levied by the state and gives as one of his arguments that in Pensylvania a 5-ton truck pays $200 into the state treasury, and that most of such trucks operating in the city of Erie do their entire traveling on the streets of that city, almost never leaving the corporate limits; but the city does not get a dollar of the tax paid by these autos. At one time the truck used by the Bureau of Street Repairs in repairing pavements had to pay a license tax to the state, but after efforts before two sessions of the Legislature, municipally owned trucks are now exempted.

Sewer Work at Glendale

Glendale, Calif., with a population of over 40,000, is said to be the largest city in America without a sanitary sewer system. However, it has recently voted bonds for $1,600,000 for constructing approximately 10 miles of outfall sewer to connect with the Los Angeles main outfall to the ocean. This year's program also includes the installation of approximately 20 miles of laterals, mostly 8-inch vitrified pipe, to be constructed in connection with street improvement proceedings. A large part of this work is already under way. The bonds also provide for constructing about 15 miles of main interceptors ranging in size from 8 to 24 inches, which are estimated to cost $278,000.

Until recently the city had no outlet for its sewage, but it has now reached an agreement with the city of Los Angeles whereby it is granted the privilege of connecting to the Los Angeles outfall in return for providing sewerage to a portion of the city of Los Angeles adjacent to the proposed sewer. It is estimated that for Glendale to build an independent outfall sewer would cost about $2,000,000.

Sewage Disposal at Columbus, Ohio

The sewage disposal plant of Columbus, Ohio, is one of the oldest of the modern plants in the country, the annual report for the year 1923 being the 16th.

As has been stated by us in previous references to this plant, the sewage is not treated at all times. During 1923 the treatment plant was operated 192 days. During the high stages of the river and creeks the sewage is discharged directly into the streams.

The Imhoff tanks removed 95% by volume of the settleable material and 58% of the total suspended solids in the fluid sewage. The average reduction in consumption of dissolved oxygen was 43%. The sprinkling filters retained 30% of the suspended solids from the tank effluent applied and decreased the consumption of dissolved oxygen 76%.

The major part of the sludge removed from the tanks was flushed into a lagoon which had been prepared during the winter of 1922-23. No nuisance from these lagoons has been apparent and this procedure has made it possible to draw the sludge from the tank whenever it was thought to be necessary. Sludge was drawn in small amounts practicaly every day except Sundays and holidays. As a result of this, 1923 was the first year through which it has been possible to operate the tanks with no foaming over the gas vents.

Pumping of sewage is necessary at several places. A new pumping station known as the "Nelson Road Station" was put into operation last June and operated continuously through the remainder of the year. During the first few weeks of operation difficulty was experienced in keeping the screens clean because of the large quantities of leaves which collected from surrounding cottonwood trees. Several of these trees were cut down, with the result that under normal conditions the screens now run about ten days between cleanings. At the main pumping station a new open-type impeller was installed last year in the 15-million-gallon DeLaval pump, which greatly increased its efficiency, and it is intended to install similar impellers in both the 10-million and 5-million-gallon DeLaval pumps at this station during the present year.

Street Widening in Uniontown

Developing a railroad alley into an important thoroughfare, by widening, paving and lighting it

By W. L. Dunn, City Engineer.

Uniontown, Pa. is situated at the western base of the Allegheny mountains, on the national pike leading from Washington, D. C. to Wheeling, W. Va., a section of what is known as the National Old Trail Road with its western terminus at Los Angeles, Calif. Tourist traffic over this road has become very heavy, especially during the summer months.

Uniontown is also the business center of the coke region of western Pennsylvania and is connected by improved roads with all the mining towns within a radius of 20 miles. The majority of the miners and farmers in this region own cars and make Uniontown their shopping, banking and amusement center. Because of this, during the past five years traffic congestion has increased to such an extent that the city authorities have been forced to make some provision for handling it.

BEESON AVENUE AT SOUTH STREET BEFORE WIDENING.
Alley 12 feet wide.

Uniontown was incorporated as a borough in 1796, and, like most old communities, its streets are narrow, very few being over 50 feet wide, while the average width of roadway is 26 feet.

In order to improve conditions, one of the first developments was the widening and extending of Beeson Avenue, which ran at right angles to Main Street for one block with a width of about 55 feet, then continued as a 12-foot alley for three blocks along side the main line of the Pennsylvania Railroad, then continued for three blocks to Fayette Street with a total width of 32 feet and a roadway width of 20 feet. Except that it provided a sort of passageway from Main to Fayette streets, it was practically worthless.

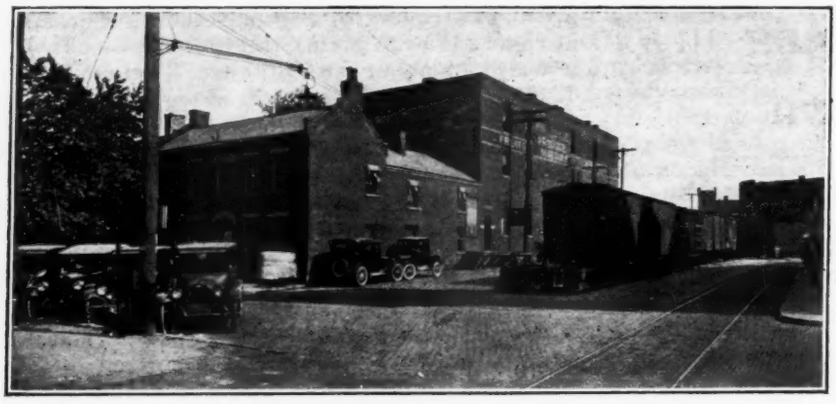
City Council decided to condemn enough land to make this street uniformly 57 feet wide with a 40-foot roadway and 8½-foot sidewalks. A bond issue for $150,000 was authorized for this work, and an additional issue for $150,000 for repairing and widening other streets was passed at the same election. After work had started on Beeson Avenue an additional amount for resurfacing over old brick and a modern lighting system was authorized which will bring the cost of this street up to about $300,000. This will be partly offset by assessment for benefits to property owners on the west side of the street, as all the land was taken from the east side.

Construction. The street was given a reinforced-concrete base consisting of 1:2:3 mix 8-inches thick, on which was placed a 2-inch wearing surface of Warrenite-bitulithic. The railroad tracks were moved from the west side of the street to the center and placed on a concrete base of the same mix, not reinforced, but 22¼ inches thick to within 2 inches of the top of the 9-inch girder rails.

Ornamental lights are spaced about 75 feet apart, connected by underground lead covered cables in fibre conduits surrounded by 6 inches of concrete. These lights are so connected up that one-half of them can be left unlighted when desired.

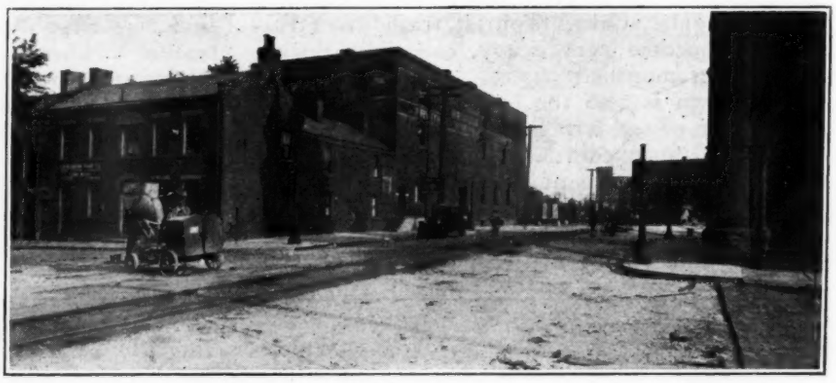
The cost of the new construction on Beeson Avenue was as follows:

BEESON AVENUE AT SOUTH STREET AFTER WIDENING.
Distance between curbs, 40 feet.



BEESON AVENUE AT CHURCH STREET BEFORE WIDENING.
Alley on right of train, 18 feet wide.

Excavation, $2.00 per cubic yard; reinforced base, $3.35 per square yard; base under railroad, $6.50 per square yard; concrete sidewalks, $3.50 per square yard; combination curb and gutter, $1.15 per lineal foot; Warrenite bitulithic wearing surface, $2.30 per square yard. The construction work on Beeson Avenue has practically all been completed except the laying of the wearing surface. The accompanying "before and after" photographs show the great improvement effected in this street for carrying vehicular traffic.



BEESON AVENUE AT CHURCH STREET AFTER WIDENING.
Distance between curbs, 40 feet.

Widening Other Streets. On many of the main streets there is a grass plot 3 or 4 feet wide on each side between the curb and the sidewalk, which will be thrown into the roadway, the curb and pole lines being moved back. This 6 or 8 feet added to the roadway will provide space for one additional line of traffic. This work has just been started and will probably require a year or more to complete. Arrangements have been made between the telephone and the light and power companies to use the same poles, which will reduce the number of poles by about 50%. On the main street running east and west the poles will probably all be taken out and the wires placed underground.

The city has been overburdened with pole lines, there being two telegraph companies, two telephone companies and a power and light company, and in addition to the poles of these companies, there have been others to support the trolley wires. As stated above, an effort is being made to secure joint use of single poles by all the companies and place the wires underground in some streets.

Severe Test of Pavement

The "Ledger" of Ballinger, Tex., tells of a severe test to which a brick pavement in that city was put last winter by a derailed coal car. The car, weighing 40,000 pounds and carrying coal waybilled for 25 tons, giving a total of 90,000 pounds, left the track at a street-crossing of the Santa Fe Railroad and rolled across the brick pavement at this crossing. In spite of the fact that this weight was carried on the flanges of car wheels, this paper reports that the only effect apparent upon the pavement was the track of the flanges in the thin coating of asphalt filler which had been left on top of the brick. A box car also crossed the pavement, but the weight of this was not so great as that of the coal car. Apparently the soil, foundation and wearing surface were all of the best to withstand such hard usage.

Pavement Cleaning in St. Louis and Chicago

In a discussion before the International Association of Street Sanitation Officials on the subject of street cleaning, Major Clinton H. Fisk, director of streets and sewers of St. Louis, stated that in that city the asphalt pavements are cleaned with a vacuum cleaner, while the brick, granite block and other pavements are cleaned by flushing and the various broom methods. "A street that is rough cannot be cleaned satisfactorily with the vacuum cleaner or by flushing. The only way we can clean a brick or asphalt street containing shell holes is with the broom, followed by white wings. We do not try to clean streets by vacuum or by flushing which have irregular surfaces or depressions, but go over them with the machine sweepers and follow in the low or irregular spots with white-wing laborers. That is about the only way we can clean such streets. We find that an irregular street or a street in bad condition usually costs two or three times as much to clean as a street in good condition of service. Believing that it is cheaper to renew such pave-

ment, we proceed to resurface and completely repave it.

"There is only one way successfully to clean irregular block streets, and that is by the brooming method. We find our vacuum cleaner tends to suck out everything there is between the blocks, and flushing to drive the filler from them." Old, irregular granite block pavements are being taken up and the blocks recut or redressed and relaid with grout filler, which new pavements give no trouble and are cleaned with a flusher.

W. J. Galligan of Chicago stated that in that city the charter under which the street-car companies operate provides that they pay the city $60 per month per mile of double track for cleaning their right-of-way. This yields the city about $280,000 a year. F. D. Furlong, street commissioner of Minneapolis, reported that that city also receives from the street railway company funds in payment for cleaning its right-of-way, Mr. Furlong's ward receiving $2,600 a year for cleaning thirteen miles of street railway and $1,600 a year for sprinkling them. Also, the company pays the cost of removing snow from a width of 19 feet, proportionate to the total cost of removing snow from the entire width of roadway.

Concerning the disposal of street sweepings, Mr. Galligan said that he had found sweepings to be essentially incombustible and that dumping was the only practicable method of disposing of them. Street sweepings from Chicago are used for filling abandoned quarries and clay holes. In gathering the sweepings, instead of leaving them in piles or windrows to be collected sometimes hours later and meanwhile be scattered by wind and traffic, Chicago places square boxes, each holding about 4 cubic feet, along the curb about three to a block, and the sweepings are placed in these to await removal. Each box is supposed to hold a day's sweepings from the length of street which it serves. It requires two men to handle them when dumping them into trucks. The boxes are made at the House of Correction by the prisoners and cost about $7.00 apiece.

In discussing snow removal, Mr. Galligan stated that he believed Chicago was the pioneer in the use of snow loaders, having bought the first one manufactured by the Barber-Greene Company. It requires only two men to a loader, which will load a truck in one or two minutes, while five or six men take fifteen minutes to load a truck. This makes it almost independent of labor, which is a great advantage, for he has found it practically impossible to get laborers to shovel snow after 10 to 12 o'clock at night, while from midnight to morning is the time when the streets can be most effectively cleaned because there is the least interference from traffic.

Old Paving Brick Relaid on Ohio State Highway

After fifteen years of service, on a gravel base, three-fourths of the brick were relaid on a concrete base

By Atlee Wise, C.E.*

Commenced sixteen years ago, and completed a year later, the first vitrified brick pavement to be built with state aid in Stark Co., Ohio, was constructed on the Alliance-Minerva-East Liverpool main market highway just outside of the Alliance city limits. The improved section was about one and one half miles long. The pavement was sixteen feet wide.

The subsoil in this region is a heavy clay, and there are many low places along the route. The pavement design, adequate for traffic of that day but totally inadequate for traffic of today in view of the character of the subsoil, provided for a six-inch gravel base, a two-inch sand bedding course, four-inch repressed brick, sand filler and a concrete curb.

The advent of the multiple-ton motor truck brought a weight and intensity of traffic that was not anticipated when this pavement was designed and built. Due to the absence of any artificial drainage whatsoever, the pavement, during the last few years, developed sink holes to such an extent that it was decided to repave it this spring.

An inspection of the pavement showed that, despite the numerous foundation failures, by far the larger number of the brick in the surface were undamaged and suitable for relaying. It was determined therefore to salvage the good brick and use them in the reconstructed pavement.

The design determined upon was a monolithic with a six-inch gravel-concrete base and cement grout filler. This was laid on the old bed and an effort was made to keep from disturbing the old gravel base any more than was necessary to install lateral tile drains at those points where foundation failures had previously occurred due to lack of drainage. Four-inch longitudinal drains were laid along both sides of the new pavement for its entire length, and where lateral drains have been installed these empty into the longitudinal lines. Disposal of the water from the longitudinal drains is made at frequent and suitable intervals.

When the brick were cleaned and piled along side of the road it was found that 75 per cent salvage had been effected, while many of the remaining 25 per cent were suitable for use in batting. The old brick surface was removed during a prolonged rainy season, and after several rains had thoroughly washed from old bricks the sand filler that clung to them, it was difficult, at a distance of 15 feet, to distinguish

*County Engineer, Stark Co., Ohio.

SUB-GRADE AFTER OLD BRICK HAD BEEN REMOVED.

where the old brick ended in the piles and where the new brick began. The salvage would have exceeded 75 per cent but that many individual bricks at those spots where foundation failures developed into sink holes, were displaced and thrown on edge, thereby suffering greater wear than ordinary and more from impact.

No cracked or broken or badly worn brick were salvaged. The only sign of use on any of the brick salvaged was a slight cobbling on the upper edges, which took place for the most part in the early life of the pavement, the sand filler affording little protection from the iron-tired traffic then prevalent.

TOOL USED TO CLEAN BRICK.

THE BRICK ON THE LEFT IS AN OLD ONE; THAT ON THE RIGHT A NEW ONE.

In the reconstruction it was determined to widen the pavement to eighteen feet. This required new brick in addition to the 25 per cent.

Despite the fact that gravel base and sand filler would not be considered adequate for present-day traffic, the writer believes that the original pavement would have offered unimpaired service for many years to come had suitable and adequate provision been made for artificial drainage. The only pronounced failures in the pavement just before it was torn up for relaying could be traced directly to lack of drainage. On the high points, where natural drainage was good, the pavement showed little signs of wear or deterioration.

It is interesting to point out that this salvage of 75 per cent in the *number* of brick amounts to more than 100 per cent salvage value when figured out on a dollars and cents basis, the brick salvaged being worth more today than was paid for all the brick laid in the pavement 15 and 16 years ago. There were about 14,000 sq. yds. in the old job. Figuring 40 brick to the yard, about 560,000 four-inch repressed brick were used, which cost about $13 per M delivered on the job 16 years ago, or a total of $7,280. About 420,000 bricks were salvaged which, at today's prices, would have cost about $36 per M. on the job, or $15,120. The cost of taking up, cleaning and piling the salvaged brick along the road was between 18c. and 20c. per square yard, or a total of about $2,100. Adding this to the original cost gives $9,380, which, subtracted from $15,120, gives $5,740, which, after a manner of speaking, might be called profit to the community.

It should be stated that little if any money was spent for maintenance of the old pavement during its entire life, except for a slight expenditure during the last few years in an effort to keep the soft spots in a condition to permit travel.

The writer estimates that the new monolithic pavement, laid as it is on the old gravel base and with adequate provision made for artificial drainage where the natural drainage is not satisfactory, will last at least 40 years, giving a life of 55 years for that portion of the original brick surface that is being used in the new construction.

The cost of the new construction is estimated as follows:

Grading	$1,801.20
Drainage	4,732.50
Artificial base	25,713.25
Surface	15,820.00
	$48,066.95

This gives about $3.00 per square yard for the new pavement.

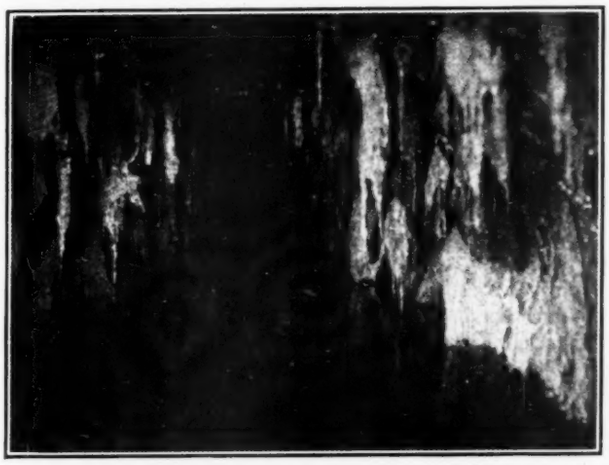
Deposits in Peabody Sewers

The sides coated 6 to 12 inches thick with hair, fats and calcium carbonate. Capacity decreased 35 per cent.

In 1922 the Massachusetts Legislature directed the Department of Public Health of that state to investigate the condition of North River in the cities of Peabody and Salem, with a view to removing or reducing objectionable conditions reported. The engineers of the State Department made a thorough investigation and reported finding conditions some of which were unusual and exceedingly interesting.

A part of the Peabody system nearest the outlet consists of combined sewers, but later extensions have been on the separate system. The sewage has to be pumped to the outlet, but the pumping plant and force mains cannot handle even the ordinary daily peak loads and it has been the practice to allow the sewage to rise in the main trunk sewer, using it as a storage basin to equalize the rate of pumping. This, of course, reduces the velocity of flow in the sewer and increases the probability of deposits. It was immediately evident that the sewer was not carrying, even at times of maximum velocity, anything like its original calculated capacity, and an investigation showed not only bottom deposits of heavy matter, but thick deposits along the sides of the sewer as well.

The chief characteristic of the sewage of Peabody is the enormous proportion of trade waste which it contains. This is derived largely from more than fifty tanneries and allied industries, including two very large glue works. The total quantity of waste from all of these averaged 3,673,000 gallons per day out of a total flow of sewage, including leakage, of 5,500,000 to 6,500,000 gallons. Naturally the sewage contains considerable matter in suspension, and analysis of a composite sample taken at hourly intervals showed fifty parts per hundred thousand of suspended solids, a quantity much greater than generally found in any other sewage in the state. The result is a heavy deposit of organic and heavy mineral matter upon the bottom and sides of the sewer. The illustration shows the 52-inch main trunk sewer with sewage flowing 30 inches deep, at a section that had been cleaned only two and one-half months previous. Only a very small quantity of heavy material



ACCUMULATION IN TRUNK SEWER.
A 52-inch sewer, cleaned 2½ months previous. Sewage flow 30 inches deep.

was present on the bottom of the sewer but a coating 6 to 12 inches thick of hair, fats and other organic matter covered with a hard scale composed largely of lime, had collected upon the sides. Measurements made after cleaning one section showed that in two weeks the accumulations had caused a 35% decrease in carrying capacity.

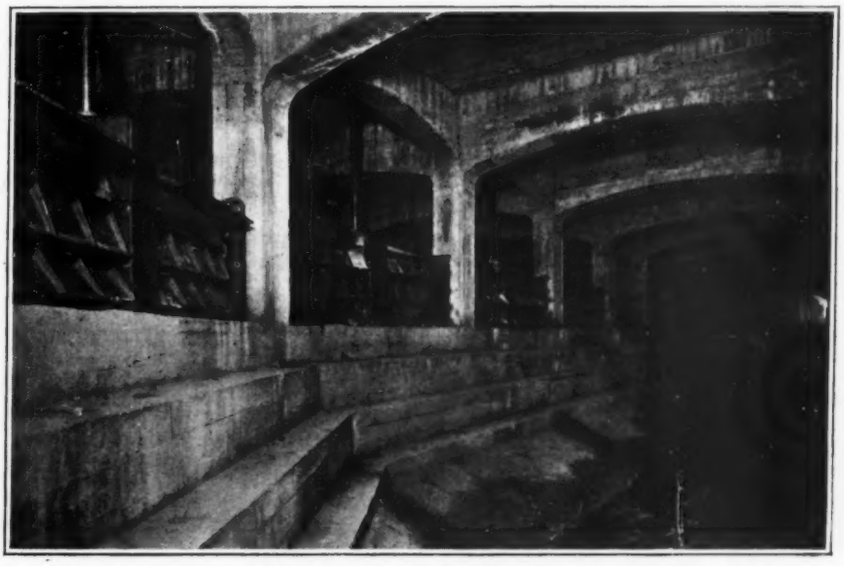
The matter composing these deposits was studied by the chemists of the department, and it was learned that the quantity of lime in the sewage was a serious factor. To discover the source, an examination was made of fifty-five industrial works, of which forty-five were tanneries handling over 7,000 dozen skins a day. These plants passed the waste water through sedimentation tanks with the resulting removal of an average of 65% of the suspended solids. In most of the plants the purification devices are well cared for and the results are as satisfactory as it is practicable to obtain with them. The lime was found to be derived almost wholly from eleven of the Peabody establishments. "It was found that much caustic lime in solution was passing into the sewers from certain plants and that most of this caustic lime, when mixed with the sewage in the sewers containing carbonic acid, was precipitated as calcium carbonate and that a carbonate scale in the sewers was one of the factors in reducing their capacity." Analyses are given of two samples of the matter hanging from the upper portions or attached to the sides of the sewer, one of these showing 62% of $CaCO_3$ and 1.4% of fat, while the other showed 38.1% of $CaCO_3$ and 10.9% of fat. In addition, the former contained 17.7% of hair, while the latter contained 29.7%. The remainder in each case was largely organic matter and magnesium carbonate.

Other conditions were considered in the report and remedies recommended. Suggested remedies for the conditions above referred to included a new and larger force main to the outlet, an increase in the pumping plant and the conducting of experiments to devise a practicable method for eliminating from the sewage the excess of caustic lime and reducing the amounts of fats, hair and other objectionable matters which find their way into the sewers. Since these now rapidly accumulate on the sewer as a hard scale from 6 inches to a foot thick, which is difficult of removal and reduces the carrying capacity of the sewer to less than 50% of what it should be, the exclusion of these substances is essential if the system is to operate satisfactorily.

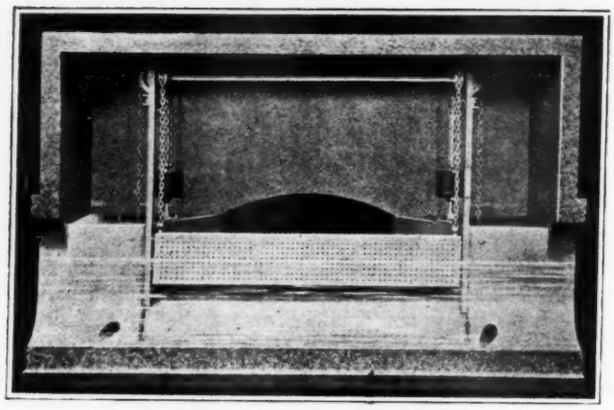
Queens Sewage Plant

A new sewage plant for the Borough of Queens, New York City, contains some interesting features that are believed to be novel in design, including sectional weir gates and a floating trash screen.

In order to regulate the amount of combined



MULTIPLE LEAF WEIR GATES IN DIVERSION CHAMBERS.



MODEL OF FLOATING SCREEN.

sewage which shall flow to the treatment plant, there is a cutoff chamber of reinforced concrete approximately 218 feet long provided with a weir over which the excess storm water flows to the storm water outlet. The novel feature of this consists of adjustable weir gates for regulating at will the amount of overflow. These weir gates are installed on top of the weir in sixteen units. Each gate consists of three leaves or stages, each leaf controlled independently and positively by means of worm gear mechanism. The control mechanism shaft passes through the center and controls the complete unit. By means of this mechanism one, two or three gates may be opened, giving a regulation of weir height with a range of 3 feet in elevation. This mechanism consists of spur gears, worm and worm gear segments, with separate spindles for controlling each of the three leaves; the control mechanism being operated from the street through a manhole. Each half of a twin gate is 4 feet 4¾ inches long by 3 feet high. They are made of cast-iron accurately machined and fitted. These gates are known as multiple leaf, twin type, weir gates manufactured by the Sanitation Corporation.

After leaving the cutoff chamber, the undiverted sewage flows by gravity about a thousand feet to a screen chamber located on the waterfront. Entrance to the treatment plant here is controlled by a sluice gate hydraulicaly operated. It then passes through a bar screen and onto two 14-foot Sanitation disc screens set at an angle of 20 degrees, the disc being perforated with twin slots 3/64-inch wide.

The screen chamber is equipped with pump and accumulator for furnishing pressure to the sluice gates, turn table and cans for screenings, I beam trolley and hoist, switchboard, electric lighting and plumbing.

Between the weir chamber and the outfall, at the junction of a 3-foot 9-inch sewer which parallels the shore and the storm sewer, is a floating trash screen, the object of which is to intercept trash coming from the 3-foot 9-inch sewer during storms. This screen is arranged to adjust itself automatically to the varying elevation of the water surface by means of floats. During dry weather the sewage flows through the floating screen chamber into the sewage treatment plant. This equipment also was furnished by the Sanitation Corporation.

South Carolina Highway Department

"The Practices and Policies of the South Carolina State Highway Department" was the subject of an address by the state highway engineer, Charles H. Moorefield, at a highway engineering conference in that state a few weeks ago.

A few of the more important features of this address are abstracted below:

The policy of the Highway Department is to have the highway system connect the main centers of population in the state with the least practicable indirectness consistent with serving a reasonable volume of local traffic. In the detailed location of a road the policy as well as the practice of this department is to locate roads between control points with a view to safety and directness. We estimate that each hundred feet of distance saved in locating a road will save in capitalized operating costs about five dollars for each vehicle per day, which the road will carry. For example, other things being equal, on a road estimated to carry 500 vehicles a day, it is worth about $2500 to shorten the average travel distance 100 feet.

In the matter of designing roads and bridges, the department is largely a follower of so-called standard practice. It has not undertaken independent investigations to a large extent but tries to profit by those carried out by others. In general, the roads are built 28 feet wide on embankments and at least 32 feet wide in cuts, and 18 feet width of pavement is aimed at. Bridges are built 22 feet wide up to lengths of 40 feet, 20 feet wide for lengths between 40 and 100 feet, and 18 feet wide for lengths greater than 100 feet. Up to the present a 7-inch uniform section has been used for concrete pavements and a 5-inch uniform section for concrete bases, with asphaltic concrete wearing surfaces 2 inches thick and sheet asphalt 3 inches thick. The mixtures are made 1:2:4 for one-course pavement and 1:3:6 for base. The 1:2:4 seems satisfactory, but the department engineers are not altogether satisfied that a 1:3:6 proportion is sufficient for a 5-inch base. Reinforcement is not used in either pavements or bases except where the subgrades are very unstable. Joints are used in all concrete pavements but none in those having bituminous tops. The joints are spaced about 40 feet apart. Mr. Moorefield stated that he is personally convinced that with the temperature and moisture changes common in South Carolina joints are a decided advantage. Bituminous tops tend to protect the base from both moisture and temperature, and cracks in the bituminous top heal themselves in warm weather. Nevertheless, in some cases black top pavements have heaved and ruptured, indicating considerable stress in the base.

The department uses 12 degrees as its maximum

curvature and 5% as the maximum grade, except that in some mountainous sections it is impossible to adhere to the rule, there being some 7% grades and curves with as short as 50-foot radius. Curves are superelevated where pavements are constructed, but not in the case of roads of the earth type, because of the greater ease of maintenance of the latter roads when they are crowned.

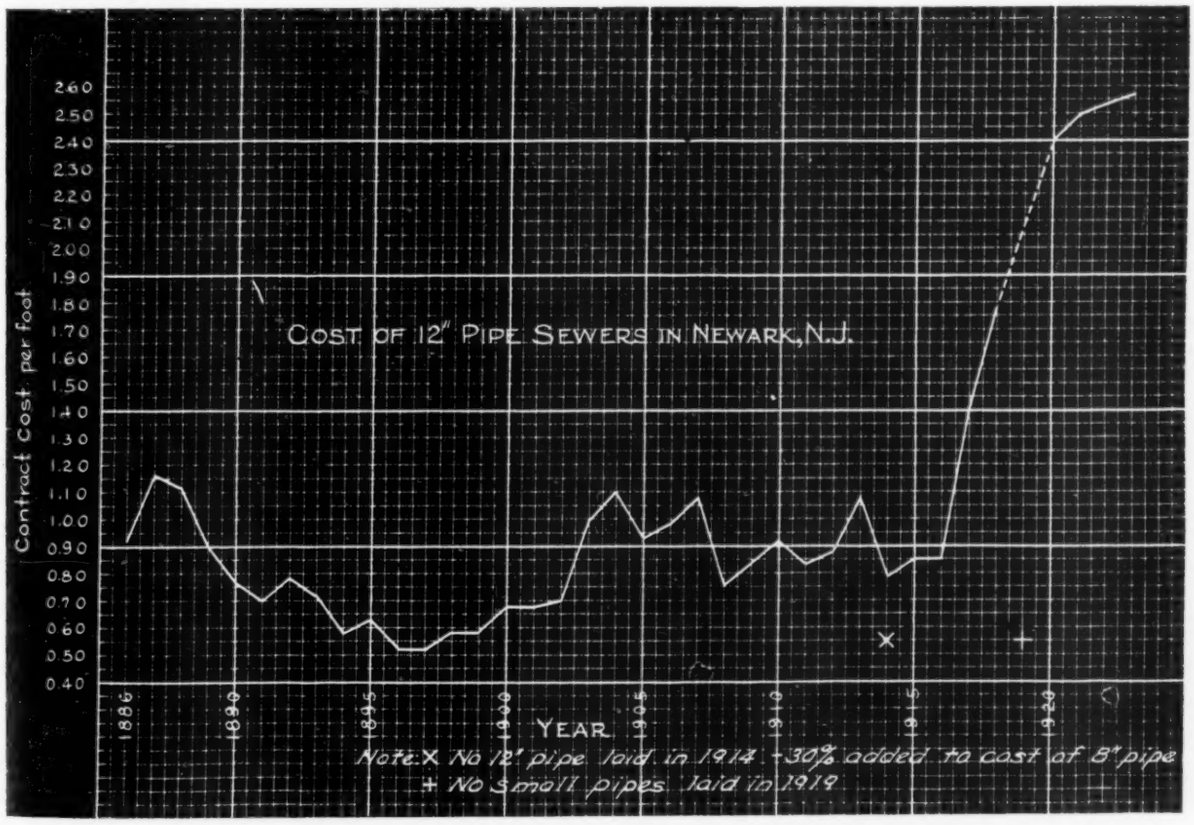
In constructing roads and bridges it is the policy to do all work by contract; although in some cases where counties have organized forces they are permitted to perform work in which they are interested. It is generally thought advisable to let the work to the lowest bidder, although in a number of cases the county officials have wished to have it awarded to local parties regardless of the bid. "The Highway Department has steadfastly refused to consider any arrangement of this kind, or to make any discrimination among contractors on any ground other than responsibility."

Concerning maintenance, Mr. Moorefield says: "The money expended for maintenance gives a quicker return to the user of roads than any other money expended. This is particularly true here in South Carolina where we have a large mileage of earth type roads and a small mileage of pavement. If earth roads are neglected, the surface becomes rutted and cut up and the cost of operating vehicles over them is materially increased. We have no very exact data as to the relative cost of operation over well maintained and neglected earth roads, but we have made some gasoline consumption tests which seem to indicate that gasoline consumption may be cut in half by properly draining and maintaining an earth road."

Cost of Pipe Sewers

In March, 1911, there was published by "MUNICIPAL JOURNAL" (the name under which "PUBLIC WORKS" was then published) a diagram prepared by Edward S. Rankin, engineer of sewers of Newark, New Jersey, showing the fluctuations in the average contract cost of pipe sewers in Newark for each year from 1886 to 1910. Mr. Rankin has recently extended this diagram to bring it up to date, and the effect of post-war conditions on the price of sewer construction appears quite plainly from the completed diagram.

In compiling the data for the original diagram, Mr. Rankin used as a basis 12-inch pipe sewers laid at an average depth of from 8 to 10 feet, because more normal contracts called for this size and depth than for any other. It, therefore, seemed desirable to use the same units in extending it. During the years 1914 and 1919 no sewers of this size were laid, but during the former year 8-inch sewers were laid and the cost of 12-inch sewer was estimated as being 30% greater than that of 8-inch in securing the figure for this year. For 1919 no approximate estimates seemed available, and in the diagram a straight line was drawn between the costs of 1918 and 1920.



COST OF PIPE SEWERS LAID IN NEWARK, N. J., FROM 1886 TO 1923.

Sewerage Plans for Springfield, Ill.

Plans for sewering a sanitary district including and adjacent to Springfield, Ill. with an area of 36.2 square miles have been prepared by Pearse, Greeley & Hansen, of Chicago, and Dawson & Walraven, of Springfield, which include some unusual features.

The sanitary district was adopted by the voters by a large majority, together with a plan for building a sewerage system and sewage disposal works estimated to cost about two million dollars.

The city is located on land which slopes to the Sangamon river on the north and east, to Spring creek on the west and Sugar creek on the southeast. Combined sewers discharge into these streams, through eleven main outlets, more than six million gallons per day of crude sewage.

While the present water supply of the city is from wells, their capacity will soon be exhausted and it is probable that water will be taken from the Sangamon river near the present works. Four sewers, to which about 20% of the population is tributary, discharge above the point where the waterworks intake will probably be located, while the others discharge below this point.

The plan of the engineers involves the customary intercepting sewers for receiving the dry weather flow and a part of the storm water flow as well. This sewage will be taken to an activated sludge plant which will serve the entire city, a district calculated for 90,000 people, or 11,250,000 gallons per day. From the sewers that discharge below the proposed intake, the intercepting sewers are designed to remove all of the dry weather flow and sufficient of the wet weather to bring the total up to 425 gallons per day from each of the 1970 population, which it is believed will prevent any pollution of the creek into which the combined sewers discharge.

The intercepting sewer receiving the dry weather flow from the sewers that discharge above the proposed intake will have a capacity to receive from them twenty-five times the dry weather flow. A high-level intercepting sewer will serve areas in the northeastern part of the district now unsewered but for which separate sewers are recommended. A considerable part of the sewage reaching this interceptor will need to be pumped, and provision is made for pumping three hundred gallons per capita, the excess beyond this during times of storm being passed through sedimentation tanks and the effluent chlorinated before discharge into Sugar creek, which discharge will be at a point almost 11 miles above the intake.

This plan will bring to the waterworks intake the overflow from the four existing combined sewers in excess of twenty-five times the dry weather flow, which overflow will, it is estimated, occur not oftener than four to six times a year, and also the unpumped sewage above referred to, which will first be settled and then chlorinated.

This deliberate discharging above the waterworks intake of mixed storm and sanitary sewage, part of which has not been treated at all and part of which has been settled and chlorinated, is defended on the ground that the supply from the Sangamon river will necessarily be filtered and disinfected in any event; that utilization of this source will require a reservoir with a capacity of probably three thousand million gallons (the maximum overflow from the existing combined sewers is calculated to be 191 million gallons per day); that such crude sewage as reaches the river will be greatly diluted and will be discharged at quite infrequent intervals; and finally, the cost of an interceptor above the waterworks intake to take the full capacity of the existing combined sewers and carry it below the proposed waterworks intake was estimated at $2,250,350.

The activated sludge process was adopted because of several local considerations, one of the chief being that power is available at the city lighting plant at a cost of only 1c. per k.w.h.; and another being because ample areas were available for lagooning the sludge.

Yield of Wells

Methods and appliances used by the Illinois State Water Survey Division in investigating wells, and some conclusions

In a paper before the annual meeting of the Illinois Section of the American Waterworks Association, G. C. Habermeyer, engineer of the State Water Survey Division, gave the results of the investigations of wells in the state made by the Division and described some of the methods and appliances used. An abstract of the paper is given below.

The yield within certain limits depends upon the depth to which the water-level is lowered, and consequently information in regard to the water-levels is secured when possible. To supplement this, or as a substitute for it when actual measurements cannot be made, information is secured regarding the capacity of pumps, depth at which pump cylinder is placed, length of air-line for air lift, and starting and operating pressures of air lifts. It is usually possible to secure information regarding the yield by measuring the discharge in a reservoir, by noting the meter readings where meters are installed or by counting pump strokes.

Small yield may be due merely to poor condition of pumping equipment. If the yield diminishes, this may be due to partial exhaustion of the supply, to a cave-in in the well, to deterioration of casing, or to deposits on and in the walls of the well due to reactions of two or more waters entering the well. Fine sand drawn against a screen often greatly decreases

the yield of a well. When a water containing considerable iron is drawn down so that air can enter the screen, a deposit may be formed that clogs the screen and the material just outside of it. At Mendota, wells in rock are cleaned of such deposits regularly twice a year by forcing a scraper to the bottom.

A well may penetrate two or more water bearing strata, the waters from which mix in the well, which mixing may cause a reaction of the contents, resulting in deposits.

Mr. Habermeyer describes several methods of measuring the depth to the ground water level, as follows:

A simple arrangement is to use a wood float, preferably weighted at the bottom so it will be held vertical, reducing the tendency of wedging in the well. The depth can be determined readily by lowering a weight and noting when it strikes the water, if other noises near by are not too great.

Mr. Beauchemin has referred to lowering a rubber hose. When the lower end reaches the water and is lowered an increase of pressure may be noted at the upper end of the hose.

A good method for regular installation is to place a small pipe of known length into the well and attach an air pump and a gauge. When pumping at a slow rate so that friction is negligible the pressure when the gauge becomes stationary is the pressure required to force water out of the pipe. Deducting this from the length of the pipe gives the depth to water. At least one pump company is leaving apparatus practically the same as we have here as equipment with some of their installations. The University of Illinois has an air pressure line connected to the pipe and the gauge so hand pumping is not necessary and the pressure can be read any time.

A magneto, which as used is practically a small dynamo turned by hand, may be used. Current is carried from one terminal on the magneto through an insulated wire which is lowered in the well. The end of the wire is protected to prevent it from touching the well casing. When the water level is struck current flows through the insulated wire, through the water to the well casing, and up through the casing or the ground to a connection which must be made from the casing or the ground back to the other binding post of the magneto. When the circuit is completed the bell of the magneto rings.

When travelling from city to city we must limit the weight carried as much as possible. Recently we have generally used an electric lighting circuit when it is available. An insulated wire carrying the current is run to a lamp and an insulated wire connected to the other terminal of the lamp is lowered into the well. When the lower end of the wire, which is protected from contact with the well casing, touches water the lamp is lighted. Electric wiring in many cities including Urbana is not all that it should be. Two wires are connected to each lamp socket and as installed it is a guess which one is carrying the current to the lamp. In order to save time we use an extension cord with one wire fastened to one lamp socket and the other wire fastened to another lamp socket. A bulb is first placed in one socket and the other terminal of that socket is connected to the ground; if the lamp does not light it is connected to the wrong wire and is put over into the other socket. Insulated wire is then connected to the second terminal of the proper socket and lowered into the well until the water level is reached as determined by the lighting of the lamp. Sufficient weight is placed on the lower end of the wire to hold it straight. The Kewanee Boiler Company has a very good apparatus of this type with the wire on a reel and the lamp socket on the side of the reel.

Mr. Bushnell and Mr. Marquardt of the Champaign-Urbana Water Company lower a wire through a small pipe placed in the well which keeps the wire straight and prevents contact with casings.

Travelling from place to place, with rough treatment of insulated wire when measuring, unwinding, winding, scraping over couplings and edges of well casing there is danger of partially destroying the insulation and allowing the current to flow from the wire at such place to the well casing or pipe flange, especially after the line is wetted. We at all time carry a protected float which can be used when there is doubt of the insulation of our wire, when there is no lighting circuit available, or where water is flowing downward in a well from a stratum above water level and might close the circuit with the electric apparatus that has been demonstrated. With this apparatus a low voltage current from one or two dry cells is connected in circuit with a buzzer or bell and two wires which are lowered into the well. The wires end in a tube in which small holes are drilled near the top and the bottom to allow air and water to flow in or out. A float held vertical with an electric conductor at the top (in this case made from a ten cent piece) is placed in the tube. When water is reached the float rises and the conductor at the top touches the terminals of the two wires, thus closing the circuit, and the buzzer operates. Very good contact must be secured to ring a bell or operate a buzzer. There is little danger from poor insulation and to save weight we use one wire insulated and the other one uninsulated. There is danger of too much insulation due to slight corrosion of the points and these must be kept bright. Mr. Siebert, Superintendent at Riverside, has used an apparatus similar to this for many years.

When we travel in auto we sometimes carry this apparatus which has the wires on a reel. The shaft is in two pieces insulated from each other with one wire connected to one piece of the shaft and the other end of the wire connected to the other piece of the shaft. The buzzer and dry cells are packed compactly in the box. This is arranged to use with the two wires and the float, but may be used with a lighting circuit using the insulated wire only.

Microscopic Plants in Sprinkling Filters

Tentative conclusions from investigations by New Jersey Experiment Station. Algae and fungi found on Filters

We have previously referred to the sewage investigation laboratory conducted by the New Jersey Agricultural Experiment Station and the State Department of Health, some tentative conclusions from the investigation having been given in our issue of January, 1924. Dr. William Rudolfs gives, in a recent issue of "Public Health News," further information concerning the microscopic plants found in the sprinkling filters, which we quote below.

The sprinkling filter at the Plainfield plant is six feet deep and made up of broken stone about 2 inches effective size. The area of the whole filter is 1.78 acres and it receives from 3 to 4 million gallons of sewage per day. In the middle of one of the 4 sections of the filter a sampling pit has been constructed. In one face of this sampling pit holes have been cut, one below the other, and extending from these holes 2 feet into the stone body of the filter. In these holes bricks and tiles have been placed for samples to be used in the study for plant, animal, and bacteriological growth.

Around the stones of the sprinkling filter beds there accumulates a slimy film, which is known to play a very important role in the purification of the sewage which passes through the film. This film is composed largely of debris, a host of bacteria, a variety of microscopic animals and an abundance of fungi. During the greater part of the year, the biological activities within this film are such that the sewage passing over it is sufficiently purified, but there are periods of the year when the film does not act properly, and the purification is not adequate. This undesirable condition of the filter bed is usually associated with a heavy film on the stones which finally breaks up and passes on through the bed into the effluent as suspended matter.

ALGAE FOUND ON THE SPRINKLING FILTER BED

The surface of the sprinkling filter bed, principally the stones which are subject to direct sunlight, is covered by a characteristic growth consisting mainly of algae. The algae are not present in great variety but are extremely abundant in quantity. The entire surface of the filter bed appears green as if covered with a sprinkling of green paint. A closer examination reveals a zoning of the green. At all points where the spray from the nozzles falls directly on the stones, the surface is covered with a bright green algae growth. Very near the nozzle and again beyond the region of heavy spray fall, there are zones of brown to grayish or greenish brown.

The green zone consists almost entirely of a well branched filamentous green algae (Stigeoclonium species?) and associated with this green filamentous alga is a one-celled green alga of the Protococcus type. Sometimes this Protococcus type grows out into filaments indicating that possibly many of these Protococcus types are only stages of the filament algae.

The brown film of the inner and outer zones is composed almost entirely of the blue-green alga, Oscillatoria. Very few other algae are present at any time of the year and these in extremely small quantities only. Fungi are almost never found on the surface of the beds.

FUNGI FOUND ON THE SPRINKLING FILTER BED

At the different levels of the filter bed there are no marked differences either in the kind or the amounts of fungi present and algae are naturally not found, since no light can penetrate into the inner parts of the bed. The fungi consists mainly of Penicillium, Beggiatoa alba, Pythium, Dictyuchus, two unidentified fungi, and filamentous bacteria.

In the fall and spring somewhat regular removals of the entire film take place, and although no differences in the kind or amount of fungi occur at the different levels, it seems that after this removal of the film, marked changes take place. This might be due to seasonal variation. In the early part of the year only small amounts of fungi are present. During March, April, and May fungi become very abundant, the maximum being reached about the end of March or the beginning of April. By the latter part of May, fungi are present in small amounts only. A similar phenomenon takes place during the fall of the year, except for a Penicillium which remains in the film to a certain extent.

During the period that fungi are the most abundant in the filter bed, the film becomes very thick and dense, even to the point of partially clogging the filter. This thick film finally begins to break up, accompanied by a disintegration of the fungous mycelium, and passes out, leaving only a thin film free from any fungous growth.

When fungi are abundant, it is clear that they act as a network in holding the film together in the nature of "binders." However, the fungi are not the only apparent binders. As the fungi disappear there is an increasing amount of filamentous bacteria and Beggiatoa alba (the latter uses sulfur for energy) which help to hold the film together. A branched gelatinous zoogleal, bacterial mass also becomes important. During the same time enormous numbers of stalked protozoans appear, apparently helping considerably in building up the film.

It is of practical and economical value to know more about these organizisms than we do at present. We know that they are an important factor in the building and holding of the film around the stones, but there is scant knowledge about their physiology. We do not know their food requirement, what products they excrete, their growth under different conditions, the influence of temperature upon them, in other

words, whether their beneficial value lies only in the building and holding of the film or in the fact that they also are a factor in the actual purification processes. At present, studies on some of the most prominent species are under way in an effort to learn more about the nature of these small plants. The fungi are isolated, studied in respect to their growth in different media, food intake and their excretion products.

Conners' Highway

A road 51 miles long is being built about halfway across the Everglades of Florida by W. J. Conners of Buffalo, which involves some very difficult work and unusual methods of solving the difficulties. This road will be a private toll road and part of a development project designed to open up the Lake Okeechobee region. It will furnish the closing link in the first coast-to-coast highway across lower Florida.

The Everglades soil is a deep black muck about 10 feet deep resting on hard marl. The material for the roadbed was obtained by removing the overlying muck and dredging out the marl, which was deposited on the roadbed alongside the canal which was thus formed. The material was not graded at first, but it was piled upon the muck and settled down through it, mixing more or less with it until the whole had reached a stage of stability. After it had dried out a light Erie revolving shovel, moving on mats, spread this marl on top to the desired width and depth of the roadbed. It is believed that the roadbed so formed will support any load that will use the highway.

Following this rough grading, a 5-ton Holt tractor and King grader smoothed the surface of the marl to the desired shape and a light tandem roller compacted it.

The wearing surface was constructed of crushed rock supplied from a central crushing plant. Platforms were built every two miles along the canal to support an unloading crane and rock brought by barge from the crusher through the canal. Ford end-dump trucks carried the rock from the several unloading points and distributed it, the truck haul thus being limited to one mile. After it got going, the work progressed at the rate of a mile and a quarter a week. The surface was rough rolled and then finished and finally given a coat of oil.

Another section running along Lake Okeechobee was built by means of five draglines which drew up on to the roadbed material from the lake bottom, which was mostly sand. The crushed stone was carried over 20 miles of 36-inch gauge railroad built for the purpose from the crusher to Lake Okeechobee. Four gasoline locomotives and two saddle-back steam locomotives were used to haul the rock and work trains. Sixty-six 4-yard side-dump cars were used. On soft grade the track was placed in the middle of the fine grade and dumped both sides. This was accomplished by placing a longitudinal partition in the car, and when the chains were knocked down, the car would dump one way or the other, and the material in the opposite compartment would then automatically pull the car over for its dump on the other side. The rock was spread by building two wings on a frame which was attached to the front end of one of the saddle-back locomotives, the material being distributed sufficiently so a tractor and grader could do the trimming up. The track was then removed, ties and rails being loaded on cars and transferred to the other end of the work. Following this the tractor and grader prepared the surface for the rollers, the rough rolling being done by a 10-ton roller, while two more 10-ton rollers followed with the necessary finishing outfit, which finished 2,000 feet of road per day.

The train service was handled with a dispatching system, a telephone line being built along the grade before the rock was distributed and each locomotive being equipped with a portable telephone. Sidings were located from 2 to 3 miles apart and a plug provided at each to which the telephone could be attached; or any locomotive could connect at any part of the line with the line wire. The dispatcher's office was located at the headquarters camp. Trains operated throughout the entire twenty-four hours.

The crushing plant was designed for crushing and washing the lime rock obtained from the St. Lucie Canal and had a capacity of 1,000 cubic yards in twelve hours. A general repair shop was located at the crusher plant and took care of all road work as well as that at the crusher. There was sufficient motive power so that one locomotive could always be out of service for any necessary repairs. Three trains were kept continually hauling rock and two work trains were used for track removal and relaying and for general work.

The total cost of the highway will be about two million dollars. The general manager is R. Y. Patterson, the general superintendent is Daniel Downey, and the chief engineer, F. E. Lawrence.

Marking Traffic Lines

Erie, Pa., according to Theodore Eichhorn, superintendent of streets, has had very good success in marking traffic lines on its streets with the use of a zoning paint made by a Cleveland company. Racine, Wis., found that the paint which it used disappeared in two or three days and last year began using a white cement, taking up bricks in the street and replacing them with this cement, which gives a permanent line. In Kenosha, two rows of brick across the street were taken up and replaced with blocks made of white cement, white sand and stone mixed about 1:1½:3. The white cement cost about $12 a barrel and was obtained from either the Atlas or the Alpha Company. The blocks are reported to have lasted well for the three years that they have been in use and the color to be as prominent as when they were laid.

Recent Legal Decisions

REGULATION OF USE OF STREETS

The Ohio Supreme Court holds, Murphy v. City of Toledo, 140 N. 7. 626, that municipalities have full power to regulate or control the use of their own streets. In such control or regulation a municipality may make any reasonable classification of vehicular traffic in the use of its streets. An ordinance under which the director of public safety of the city might issue an order prohibiting the operation of buses in certain restricted districts was held valid.

RATES FOR STREET LIGHTING

The North Dakota Commission is of opinion that municipalities should bear their proportionate share of the expenses of maintaining an electric utility by paying compensatory rates for street lighting, although a city or town is entitled to a slightly reduced rate because of the fact that it is a large consumer and the expense of reading meters and billing is smaller. It believes that street lights should be put on a meter basis instead of a flat-rate basis. Pembina Light & Power Co. Case No. 1523.

ENGINEERS ORAL INTERPRETATION OF SPECIFICATIONS HELD BINDING—CONCRETE WORK ON BASIS OF USING LOCAL STONE

Specifications for the concrete work for additions to the water system of a town provided that in case of difference of opinion as to the meaning of any specification, bidders must ascertain and bid on the engineer's understanding of it, and that his decision should be final and binding. Bidders asked the engineer if they could base their bid under a specification providing for "broken stone" on the use of local stone, and he said they could. The New Hampshire Supreme Court held, Osgood Const. Co. v. Town of Claremont, 122 Atl. 346, that the contract, which was subsequently awarded to such bidders, was based on the use of local stone; and when the contractors were required to use foreign stone because local stone was found to be unsuitable, they were entitled to be recompensed for the increased expense, the municipality having taken the risk of the suitability of the local stone.

BONDED INDEBTEDNESS NO DEFENSE TO SUIT TO COMPEL PROPER DISPOSAL OF SEWAGE

The New Jersey Court of Chancery holds, Department of Health v. City of North Wildwood, 122 Atl. 891, that the fact that the bonded indebtedness of a city already equals the statutory limit thereof does not constitute a defense to a suit under New Jersey P. L. 1907, c. 135, by the State Department of Health to compel such city to cease the pollution of certain waters of the state by its sewage disposal system, and to provide a proper sewage disposal plant. It is also held that the Court of Chancery has no power to entertain an appeal from the findings of the State Sewage Commission (now the State Department of Health), after the expiration of the time limited for such appeal in the statute.

REJECTION OF LOWEST BID MUST BE JUSTIFIED

To justify the governing body of a municipality in rejecting the bid of the lowest bidder for a public work, under chapter 152 of the New Jersey Laws of 1917, requiring advertisement and award to the lowest responsible bidder of work over $500 in amount, the New Jersey Court of Errors and Appeals holds, Paterson Contracting Co. v. City of Hackensack, 122 Atl. 740, that there must be such evidence of the irresponsibility of the lowest bidder adduced as would justify a belief on the part of fair-minded and reasonable men that it is not for the best interest of the municipality to award the contract to the lowest bidder.

MEMBER OF PAVING CONTRACTOR FIRM CONTRACTING WITH BOROUGH NOT AN EMPLOYEE OF BOROUGH

A member of a partnership of contracting bricklayers and stone masons which contracted to do such bricklaying as a borough required at a stated sum per hour was fatally injured by a passing automobile while working alone in repairing the brick roadway of a borough street. The partnership employed a number of men, the difference between the wages paid them and the amount received from the borough being the firm's profits. The firm carried workmen's insurance, the cost of which they included in their charge to the borough. The Pennsylvania Supreme Court holds, Swartz v. Borough of Hanover, 122 Atl. 215, that the deceased was an independent contractor, and not an employee of the borough, which was not liable for compensation for his death under the Workmen's Compensation Act.

CONTRACTOR'S BOND FOR MUNICIPAL PUBLIC WORK HELD NOT TO CREATE OBLIGATION TO LABORERS OR MATERIALMEN

The Pennsylvania Supreme Court holds, City of Erie v. Diefendorf, 122 Atl. 159, that a contractor's bond for public work required by a city ordinance, which provided that the city could, on the failure of the contractor to do so, pay the workmen and for material used on the work and deduct the amount so paid from sums due him, or recover the amount from him, his sureties being expressly holden therefor, was intended merely to guarantee the city against loss on account of such payments, and in no sense created or acknowledged a direct obligation to laborers and materialmen. The acceptance of the bond was held not to have been intended as an exercise of the city's power under the Pennsylvania statute of 1917 to require from contractors an "additional bond" for the use of laborers and materialmen.